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Connecticut Comprehensive Ambient Water Quality Monitoring Strategy

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I. Introduction

The purpose of this plan is to describe the objectives, scope and plans for implementation of ambient surface water monitoring activities conducted on inland waters by the Connecticut Department of Environmental Protection (CTDEP), Bureau of Water Management (BWM). Ambient monitoring of marine waters is also conducted by the BWM under the Long Island Sound Study (LISS). The LISS is a component of the National Estuaries Program and the Department released "A monitoring Plan for Long Island Sound" in 1994. This plan has been modified slightly and is included here as Appendix A.

The Federal Clean Water Act (CWA) (sections: 106, 319, 314, 303, 305(b)) and the Connecticut General Statutes (sections: 22a-424(e), 22a-426(d)) provide the regulatory context and mandate for the Department's water quality monitoring and assessment program. This comprehensive monitoring and assessment plan was developed pursuant to guidance issued by the USEPA under Section 106 (e)(l) of the CWA (USEPA 2003). The guidance document recommends that state plans contain ten basic program elements to meet the monitoring requirements of the CWA that` are to be fully implemented by the year 2014. The ten program elements are shown in Table 1 and will be discussed further below as sections II through XI.

Table 1. Program Elements Recommended by EPA

1	Monitoring program strategy
2	Monitoring objectives
3	Monitoring design
4	Core and supplemental water quality indicators
5	Quality assurance
6	Data management
7	Data analysis and assessment
8	Reporting
9	Programmatic evaluation
10	General support and infrastructure planning

II. Monitoring Program Strategy

The purpose of this strategy is to describe how the CTDEP's limited monitoring resources can be most efficiently deployed to: 1) achieve the ambitious goals of monitoring and assessment of all State waters within the next ten years, and, 2) to also answer the specific questions regarding water quality that are needed to manage Department programs. Current ambient monitoring projects are described, as well as planned projects that can be accomplished with existing resources. Perceived impediments to what EPA guidance describes as an adequate state-monitoring program are identified, and recommendations are include on how additional resources might be utilized if they become available.

Development of a strategy intended to prescribe a wide range of monitoring activities over a ten-year period is inherently difficult. It is essential that any comprehensive monitoring strategy be flexible enough to accommodate potential changes in program priorities, uncertainty of available resources and staff expertise, and emergence of unforeseen issues.

To accomplish the goals of this strategy we will need to employ a combination of targeted and probabilistic monitoring designs over an extended time period. Targeted monitoring is designed to answer specific questions regarding status and trends, pollution control effectiveness, damage assessment, waste load allocation, etc. at predetermined locations. This type of information is waterbody specific and is an essential component of State water resource management activities. This ten-year strategy will replace and incorporate components of a Five-Year Rotating Basin Strategy based on a targeted sampling design that was completed in 2001 (CTDEP 1999).

Probabilistic or statistically based monitoring designs can be used to answer questions regarding designated use impairment status on a statewide, regional or national scale for discreet resource categories within the various sample populations; rivers, lakes, estuaries, etc. This type of information is used by states and EPA primarily to fulfill reporting requirements under the CWA. A statewide probabilistic survey of wadeable streams was completed in 2004 and components of this type of project design will also be incorporated into the current ten-year strategy.

III. Monitoring Objectives

Ambient monitoring is the acquisition and interpretation of data that can be used to characterize the physical, chemical or biological integrity of surface waters. A list of monitoring objectives is presented below. However, monitoring programs are best designed to answer questions. Some examples of typical questions usually associated with the broader objectives are also included.

- Protection of public health
    - Are fish safe to eat?
    - Is it safe to swim?
- Evaluation of pollution control program effectiveness
    - How effective are pollution control projects and programs?
- Baseline characterization and identification of reference conditions
    - What are typical water quality conditions across the State and what are the characteristics of the resident biological communities they support?
    - What waterbodies are exceptional in quality and what watershed attributes are important?
- Assessment of water quality trends
    - To what extent is water quality changing over time?
- Evaluation of ecological damage due to emergency pollution events
    - What are the environmental impacts from oil and chemical spills, sewage leaks, etc.?
- Identification of existing and emerging pollution problems
    - What waters are impaired and why?

    - What levels of legacy pollutants are present in sediment or biological tissues?
    - What waters contain endocrine disrupting compounds or other emerging contaminants and what are the environmental and human health effects?
- Investigation of nuisance complaints
    - Why is a river or lake discolored?
    - What caused a fish kill?
- Meet reporting commitments required by State and Federal regulations, especially sections 305(b) and 303(d) of the CWA.
    - Which specific waters meet or do not meet water quality standards and why?
    - What is the statewide proportion of waters in each use-support category?

Short-term goals and objectives are typically described in annual monitoring work plans. Annual work plans are prepared prior to the respective data collection period. The plans identify projects to be accomplished by the various program elements within an annual monitoring and assessment cycle. Project goals, sampling locations, parameters, methods, and time frame are included in the annual work plans. The work plans are circulated for comment to relevant management and technical staff.

IV. Core and Supplemental Water Quality Indicators

The goals and objectives of a monitoring program strongly influence selection of appropriate environmental indicators, which in turn determine appropriate data collection needs. A common element to most of the goals and objectives listed above requires the determination of designated use support status relative to CT Water Quality Standards (WQS). The CT WQS document contains policy statements concerning the protection of water quality and describes the classification of State waters (CTDEP 2002a). Described for each Class are: 1) allowable discharges; 2) numeric or narrative criteria for various parameters to maintain water quality, such as dissolved oxygen and indicator bacteria, and; 3) designated uses that should be supported. The extent to which waterbodies support their designated uses is the key element in CWA reporting requirements. Designated use support is effectively the measure of water quality used for most other water quality assessment purposes. Designated uses are presented in Table 2 for the various CT water quality classifications along with environmental indicators used to determine designated use-support. A more detailed discussion of assessment criteria and use-support thresholds can be found in the *Connecticut Consolidated Assessment and Listing Methodology for 305(b) and 303(d) Reporting* (CTCALM) (CTDEP 2004a). Monitoring and assessment of designated use-support for shellfishing is the responsibility of the CT Department of Agriculture, Aquaculture Division. The CT Department of Public Health and the water supply utilities share responsibility for monitoring and assessment of use-support for public water supply. Consequently, these monitoring programs are not included in this document but are described in the CT CALM (CTDEP 2004a).

Table 2. Designated uses for surface waters as described in Connecticut Water Quality Standards and corresponding environmental indicators.

CWA Designated Use	**CT WQS Designated Use**	**Applicable Class of Water**	**Functional Definition**	**Core** / *supplemental* **Environmental Indicators**
Primary Contact Recreation	Recreation	AA, A, B, SA, SB	Swimming, water skiing, surfing or other full body contact activities.	**Indicator bacteria** *Known threats to public health*
Secondary Contact Recreation	Recreation	AA, A, B, SA, SB	Boating, canoeing, kayaking, fishing, aesthetic appreciation or other activities that do not require full body contact.	**Indicator bacteria** *Known threats to public health* *Excessive algal or weed growth*
Aquatic Life Support	Habitat for fish and other aquatic life and wildlife.	AA, A, B, SA, SB	Waters suitable for the protection, maintenance and propagation of a viable community of aquatic life and associated wildlife.	**Aquatic community structure/** *Conventional and toxic chemical pollutants*
Fish Consumption	Not specified as a use, but implicit in "Habitat for fish and other..."	AA, A, B, SA, SB	Waters supporting fish that do not contain concentrations of contaminants, which would limit consumption to protect human health.	**Tissue contaminants (mercury, PCBs, pesticides)**
Shellfishing	Shellfish harvesting for direct human consumption where authorized.	SA	Waters from which shellfish can be harvested and consumed directly without depuration or relay. Waters may be conditionally approved.	**Indicator bacteria** (Monitoring and assessment are conducted by the CT Dept. of Agriculture, Aquaculture Division)
Shellfishing	Commercial shellfish harvesting where authorized.	SB	Waters supporting commercial shellfish harvesting for transfer to a depuration plant or relay (transplant) to approved areas for purification prior to human consumption (may be conditionally approved); also support seed oyster harvesting	**Indicator bacteria** (Monitoring and assessment are conducted by the CT Dept. of Agriculture, Aquaculture Division)
Public Water Supply	Existing or proposed drinking water supplies.	AA	Waters presently used for public drinking water supply or officially designated as potential public water supply.	**Indicator bacteria, toxic chemicals** at intake structures (Monitoring and assessment are conducted by the CT Dept. of Public Health and public water supply utilities)
Public Water Supply	Potential drinking water supplies.	A	Waters that have not been identified, officially, but may be considered for public drinking water supply in the future.	N/A
Navigation	Navigation	A, B, SA, SB	Waters capable of being used for shipping, travel or other transportation by private, military or commercial vessels.	N/A
Industrial	Water Supply for Industry	AA, A, B, SA, SB	Waters suitable for industrial supply.	N/A
Aesthetics	Not a designated use but included in narrative criteria.	AA, A, B, SA, SB	Appearance, odor or other characteristics of water, which impact human senses, are acceptable.	**Turbidity, visual or sensory observation** *Excessive algal or weed growth*
Agricultural	Agriculture	AA, A, B	Waters suitable for general agricultural purposes.	N/A
Overall		AA, A, B, SA, SB	Waters supporting all of their designated uses.	N/A

A comprehensive list of core and supplemental water quality indicators were identified and categorized by the Interagency Task Force on Monitoring Water Quality (ITFM 1995). Yoder (1997) further discussed and described three main indicator categories in the context of their roles in adequate state watershed monitoring and assessment programs as follows:

- *Stressor indicators* - measures of activities, which have the potential to impact the environment (examples are pollutant loadings, land use characteristics, habitat changes, etc.).
- *Exposure indicators* - measures of change in environmental variables that suggest a degree of exposure to a stressor expressed in magnitude or duration (examples are water column or sediment pollutant concentrations, toxicity response levels, habitat quality indices, biomarkers).
- *Response indicator*s - composite measure or expression of an integrated or cumulative response by an aquatic community to exposure and stress (examples are biological community indices, aquatic community structure metrics, or status of an index species).

Both documents make a strong case for the use of response indicators to evaluate aquatic life use-support (ALUS) and caution against the inappropriate substitution of stressor and exposure indicators for that purpose. We believe that the stressor / exposure / response paradigm is the appropriate model for managing aquatic systems and have adopted aquatic community structure measures (response indicators) as our core indicators for ALUS. Conventional and toxic pollutant levels in water and sediments (exposure indicators) are used as supplemental indicators for ambient assessment of ALUS, but may be core indicators for special purposes like monitoring for Total Maximum Daily Load (TMDL) or remediation projects.

The core indicators for water contact recreation and fish consumption are indicator bacteria and tissue contaminants respectively. These are difficult to characterize since both share characteristics of exposure and response indicators. Use support for water contact recreation may also be determined by presence of known threats to public health such as combined sewer outfalls or the presence of infectious material.

Stressor indicators like land use characteristics, pollutant loadings and habitat quality have been used as core indicators for selection of reference sites and some preliminary efforts to classify sites for biocriteria development.

V. Monitoring Design

A. Historical and Recent Monitoring Approaches

Rotating Basin Approach 1996-2001

Ambient water quality monitoring of rivers in Connecticut has historically employed a focused approach targeting approximately 893 miles comprised primarily of major rivers and waste receiving waters, consequently many smaller streams remained un-assessed. In an effort to prioritize surface water monitoring activities and increase monitoring coverage, a five-year Rotating Basin Monitoring Strategy was developed and implemented in 1997 following existing Sec.106 and 305(b) guidance (CTDEP 1999).

The State contains a total of approximately 5,830 miles of rivers and streams (USEPA 1993). The Connecticut DEP has organized the hydrography of the State into a hierarchical system of natural drainage basins comprised of four basic levels of magnitude (CTDEP 1981). Major basins represent the greatest level of magnitude and are roughly equivalent, but not identical to USGS eight digit cataloging units. Major basins are comprised of three categories of sub basins. In order of decreasing magnitude these are regional, sub regional, and local basins. The distribution of drainage basin units at each level of magnitude is listed below.

Major basins	8
Regional basins	45
Sub regional basins	336
Local basins	2,893

Under the Rotating Basin Strategy the State was divided into five hydrologic assessment units comprised of one or two CTDEP major basins, or USGS cataloging units. All regional and most sub regional basins were monitored. The assessment units are listed in Table 3 and shown in Figure 1.

Table 3. Rotating Basin Assessment Units

CT DEP Major Basin		USGS Cataloging Unit
Housatonic	6000	01100005
Southwest Coastal Southcentral Coastal	7000 5000	01100006 01100004
Connecticut	4000	01080205 01080207
Upper Thames	3000 (3100-3800)	01100002 01100001
Lower Thames Southeast Coastal Pawcatuck	3000 (3900) 2000 1000	01100003 01100003 01090005

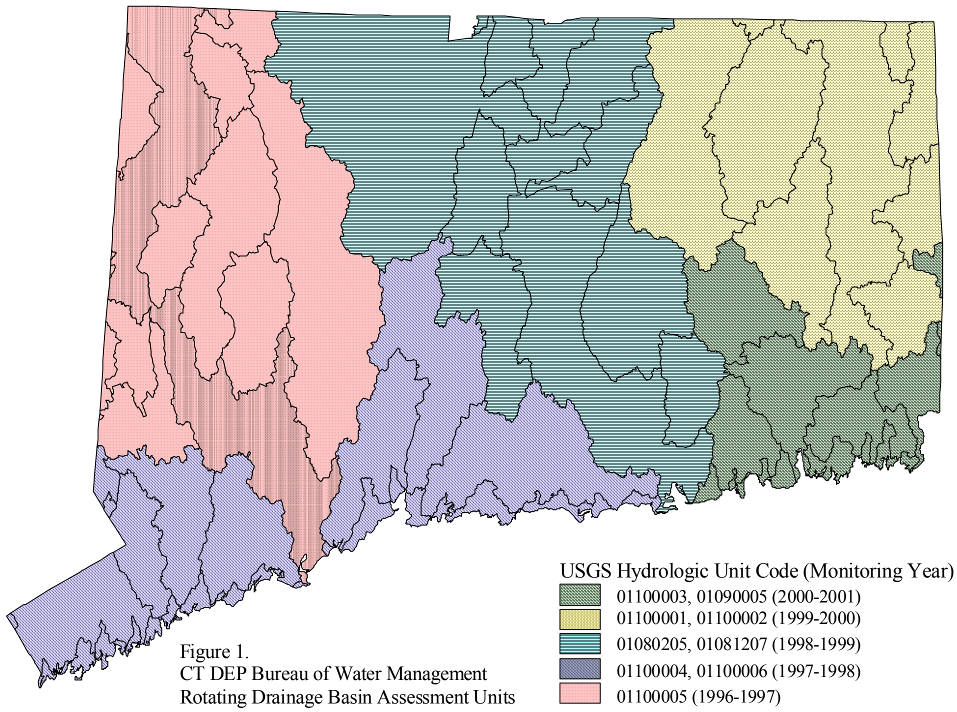


Figure 1.
CT DEP Bureau of Water Management
Rotating Drainage Basin Assessment Units

The Rotating Basin Strategy addressed the following six program elements.

1. Physical chemical monitoring
    a. Cooperative USGS fixed network
    b. Rotating physical/chemical network
2. Biological monitoring
    a. Ambient biological monitoring
    b. Aquatic toxicity testing
    c. Tissue contaminant monitoring
3. Intensive water quality surveys
4. State Park beach monitoring
5. Volunteer monitoring
    a. Tiered approach
6. Technical assistance and review

One assessment unit was targeted each year during the five-year cycle, which ended in 2001.

Sampling locations are shown in Figure 2. An increased effort was made to incorporate monitoring data from volunteers, academics and municipalities. At the completion of the full basin rotation in 2001, the number of assessed stream miles increased from 893 (15%) in 1996 to 1,461 (27%) for aquatic life use and 1,197 (22%) for contact recreation.

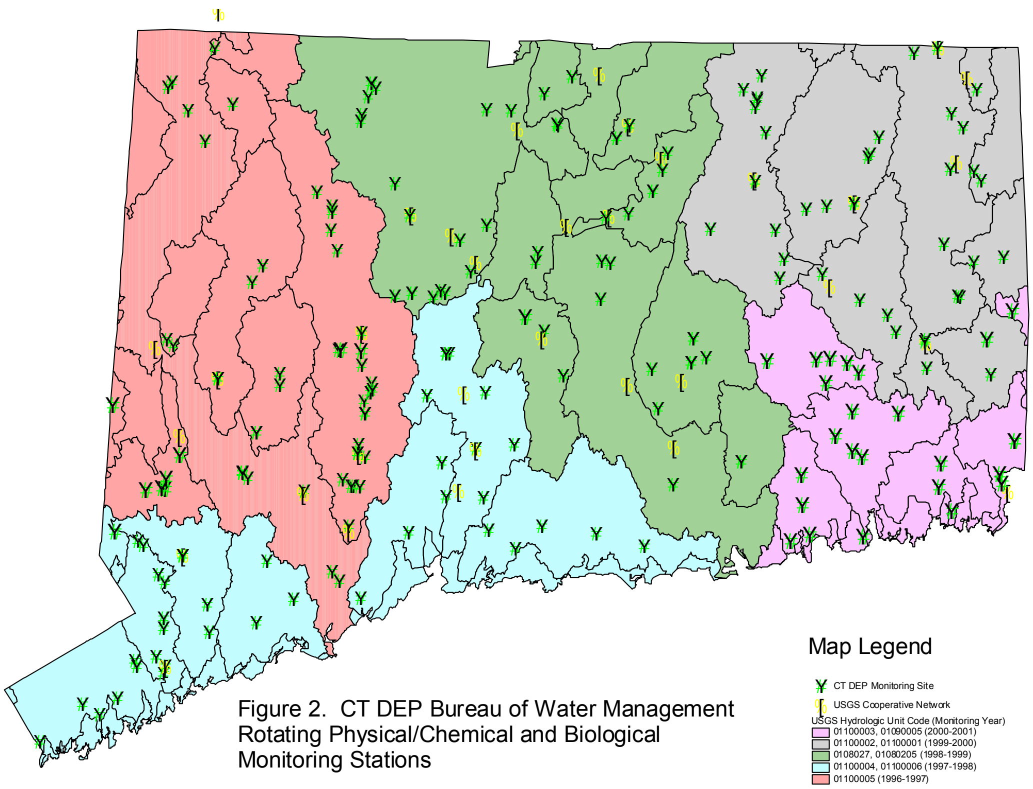


Figure 2. CT DEP Bureau of Water Management Rotating Physical/Chemical and Biological Monitoring Stations

The Monitoring Program has made significant progress since adopting the Rotating Basin Strategy in 1997 as indicated by the following milestones.

- Hired three full-time Monitoring Program staff
    - Volunteer monitoring coordinator/data manager/biologist
    - Dedicated Sec. 305(b) position
    - GIS support position
- Updated equipment used for monitoring field parameters
- Implemented electronic data management linked to GIS for all data
- Began migration of monitoring data to EPA STORET
- Institutionalized a tiered, quality-assured volunteer monitoring program
- Completed a statewide probabilistic survey of wadeable streams
- Incorporated fish and community data into the Monitoring and Assessment Program
- Currently evaluating periphyton community data for inclusion as an assessment tool
- Completed 305(b)/303(d) reporting commitments on schedule since 1998

Probabilistic Monitoring 2002-2004

Despite the increase in monitoring coverage, the focused monitoring described above cannot be extrapolated to meet the CWA requirement to comprehensively assess all waters of the State. To work toward the goal of a comprehensive assessment, the Department accepted the opportunity to participate with the EPA Region I OEME Laboratory in a two-year monitoring project following completion of the five-year rotating basin strategy in 2001. This project was conducted from 2002 to 2004 and assessed wadeable streams based on a statewide probabilistic design. Sample coverage included biological monitoring of fish, invertebrate and periphyton communities, and quarterly water chemistry at the sixty sites shown in Figure 3. This probabilistic sampling effort was part of the New England Wadeable Stream (NEWS) project, funded under the EPA Regional EMAP (REMAP) program. Data from this project is currently being evaluated by a workgroup made up of biologists from the NE states and EPA using a model based tiered aquatic life uses along a human disturbance gradient. Contractor support is also being provided by EPA Headquarters.
During 2002-2004, in addition to probabilistic sites, DEP conducted monitoring at reference sites, sites with known problems and intensive surveys prior to or following TMDL implementation.

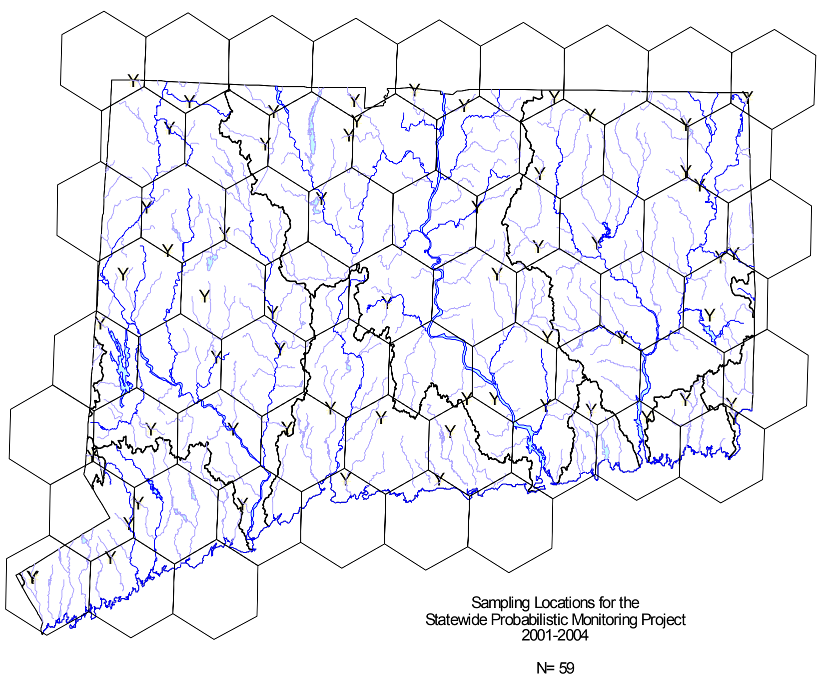


Figure 3. Probabilistic monitoring sites

B. Existing Program Elements

The Bureau of Water Management relies on a variety of program elements that employ different methodologies to acquire environmental data for the assessment of water quality. The various program elements and their relationship to the overall ambient monitoring effort are described below.

Monitoring for Water Column Parameters

Cooperative DEP/USGS Primary Physical/Chemical Monitoring Network

This network is a long-term cooperative venture between the CT DEP and the United States Geological Survey (USGS). The network is maintained by the USGS, Hartford office under a 50/50 funding arrangement with the DEP that dates back to the early 1970's. Currently, water quality data are collected at 33 sites on 15 rivers. Over 30 physical and chemical parameters are monitored at an average frequency of eight times per year. Sampling sites are located primarily on the State's largest rivers, interstate rivers, waste receiving streams, and selected reference sites. Sampling site locations are shown in Figure 2 above. Over the past decade coverage has been reduced by approximately 50% due to increasing costs and diminished funding. This project provides reliable, high quality data that describes the physical and chemical characteristics of the rivers monitored. Many of the sampling sites also include continuous streamflow measurement, which is conducted under an associated cooperative project. The data are used to support trend assessment, to determine compliance with water quality standards, estimate loading, and establish reference conditions on minimally impaired waters. Many of these sites have been monitored for an extended time period and represent a considerable investment in support of trend monitoring that is unique in the Country. These sites will continue to be monitored at an optimum frequency to take advantage of their extended period of record. A small subset of primary network sites will be rotated in an effort to expand coverage and support the rotating basin approach. However, due to the need for a multi-year period of record at monitoring sites by the USGS, the rotation may not be entirely consistent with the rotational basin schedule.

A new component was added to the network in 1998, which continuously monitors field parameters over extended time periods. This is accomplished by deployment of self-contained monitoring instruments, which store data internally (Yellow Springs Instruments, model 6000). These instruments measure temperature, specific conductance, pH, dissolved oxygen and turbidity. They are deployed for up to 10-day intervals at selected network sites and will continue to be used with an emphasis on future rotating basin schedules, TMDL development and other priority issues.

Rotating Secondary Physical/Chemical Monitoring Network

This network was intended to supplement the primary network sites during the rotating basin period by providing physical/chemical (p/c) data on selected rivers. Sampling frequency was quarterly for one year consistent with rotating basin scheduling. Third quarter sampling events were coincident with critical stress periods characterized by low streamflow and elevated water temperature. Sampling site selection was based on a targeted approach considering sub basin size, location of wastewater discharges, land use, and resource value. Sampling site locations are shown in Figure 2. Conventional water quality parameters, toxic metals, and indicator bacteria were measured by means of grab samples. Sample collection and field measurements were performed by personnel from the DEP, Bureau of Water Management. Laboratory analyses were conducted by the CT Department of Public Health (CTDPH), Laboratory Division, and /or the Environmental Research Institute at the University of Connecticut.

Biological Monitoring

Ambient Biological Monitoring

Ambient biological monitoring characterizes water quality by evaluating the biological integrity of resident communities of aquatic organisms. Biological monitoring has been conducted by the DEP Bureau of Water Management since the early 1970's and has focused primarily on the benthic invertebrate community of wadeable stream segments. Approximately 428 sites on 207 rivers have been monitored to date (spring 2005). Assessments are based on community structure characteristics using techniques that are intended to minimize the influence of variables such as habitat, seasonality and sampling method. Methodology has followed a modified version of the USEPA Rapid Bioassessment Protocol (RBP) III since 1989 (Plafkin, et al 1989). Under the Rotating Basin Strategy, benthic invertebrate monitoring was conducted at approximately fifty sites each year corresponding to the rotation schedule described above. During the two-year probabilistic sampling strategy described above, thirty randomly selected sites were sampled annually as well as about twenty targeted sites for reference, TMDL or other special projects. Since biological monitoring integrates environmental conditions over an extended time period, each site is typically sampled only one time, usually during the fall. This is the optimal index period for detecting stressed communities. Spring sampling is conducted on a limited basis for special studies or to supplement fall sampling.

Under the Rotating Basin Strategy described above (1997-2001) site selection corresponded to and was coordinated with the physical/chemical sites shown in Figure 2 during years when these sites were included in the active rotational assessment unit. During both rotating and probabilistic sampling protocols, approximately ten regional reference sites located across the State were also sampled annually.

The monitoring program has historically relied on in-house expertise for benthic taxonomy. However, due to the recent loss of one of our two benthic taxonomists to retirement we have begun to contract out benthic identifications. Since benthic community assessment is the cornerstone of our program to assess ALUS, adequate funding for this critical program element is a major priority to maintain the integrity of our ambient monitoring program.

The Monitoring Program has long recognized the value of obtaining a broader perspective of biological integrity by incorporation of fish community assessment data into the biological monitoring process. This has been accomplished to a limited degree by a cooperative working relationship with the CTDEP Division of Inland Fisheries. Fish sampling information obtained by fisheries biologists for purposes consistent with the fisheries management program has been utilized in the form of best professional judgment assessments which we consider to be generally equivalent to USEPA RBP IV (Plafkin, et al 1989). In an effort to develop a more quantitative approach directed at specific water quality issues, funds obtained through an EPA 104(b)(3) grant have supported part of a Fisheries Division staff position beginning in 1999. This has allowed for approximately 230 fish community samples on 151 streams to date, equivalent in effort to RBP V (including the thirty probabilistic sites described above). The intent of this project is to support development of fish community structure metrics that will provide a more quantitative approach to our assessment process. Funding for this project will expire after the 2005 sampling season.

A pilot project to monitor periphyton was appended to the two-year statewide probabilistic survey of wadeable streams in 2002 – 2003. EPA nutrient criteria development funding supported this work. EPA RBP periphyton methods for natural substrate and rapid qualitative assessment were followed (Barbour, et al. 1999). Laboratory analysis was contracted with the University of Michigan. The intent of this project was to evaluate the utility of periphyton as an ambient monitoring tool and that evaluation is currently in progress.

Aquatic Toxicity Testing

CTDEP operates an aquatic toxicity laboratory, which began operation in 1984 as part of the Aquatic Toxicity Program. Support of this program remains its primary function. This laboratory routinely tests wastewater effluents and surface waters for toxicity to aquatic organisms by exposing test organisms to water or effluent samples under controlled laboratory conditions. Currently, testing is conducted with three species of test organisms. These include two invertebrate species: *Daphnia pulex*, and *Ceriodaphnia dubia* (water fleas), and one fish species: *Pimephales promelas* (fathead minnow). The invertebrates are cultured at the DEP Laboratory, fish are obtained as eggs from USEPA. In general, two types of toxicity tests are conducted. Acute tests are of relatively short duration and measure mortality of the test organisms as the test endpoint. Chronic tests are of longer duration and measure growth rate or production of offspring as test endpoints in addition to mortality. Most of the testing done by DEP is for acute toxicity.

Effluent toxicity data are used to evaluate permit compliance and in some cases to support enforcement actions. Toxicity testing data have also been used to quantify the assimilative capacity of surface waters to toxic compounds. This is a necessary step in establishing water quality criteria and waste load allocations.

The toxicity laboratory also provides quality assurance oversight for toxicity data provided by contract laboratories. All private toxicity laboratories that provide discharge toxicity monitoring services to Connecticut industries and municipalities in fulfillment of permit requirements participate in the toxicity laboratory’s QA/QC program, and follow approved protocols for testing.

Toxicity testing has been conducted in support of the rotating basin assessment strategy. The goal was to conduct effluent testing on all National Pollutant Discharge Elimination System (NPDES) major discharges in the hydrological assessment unit consistent with the schedule of rotation. Ambient chronic toxicity testing has been conducted with the assistance of the USEPA Region I OEME laboratory at Chelmsford, MA. This testing has been conducted on selected stream reaches within the subject assessment unit as the need is indicated by the results of biological monitoring, and the nature, location, and compliance history of toxic pollution sources. Since the aquatic toxicity laboratory is primarily tasked to support the aquatic toxicity program, testing is also conducted as needed outside of any existing rotation schedule.

The capacity of the Bureau to support an in-house aquatic toxicity laboratory is currently under review. This is due in part to the high level of effort assigned to the toxicity laboratory relative to other ambient monitoring activities and the limited resources available overall. A comprehensive internal evaluation of the costs and benefits of the laboratory relative to the strategic needs of the agency was completed in 2004 and Bureau management is currently assessing the various alternatives. More specific information on resource allocation is presented in Section XI.

Tissue Contaminant Monitoring

Monitoring of toxic contaminants in tissues of fish and invertebrates has been conducted since the late 1970's in cooperation with the CTDEP Fisheries Division, and the CTDPH Environmental Epidemiology Section. Chemical analyses are conducted under contract with the CTDPH Laboratory Division, or the University of Connecticut, Environmental Research Institute. The primary purpose of this monitoring has been screening for human health risk, or more intensive assessment for development of fish tissue consumption advisories for individual water bodies. Since 1985, methodologies for fish tissue samples prepared for human health risk assessment have followed Federal Department of Agriculture guidelines for edible portion (USFDA 1978). In situations where ecological risk was the primary issue, whole fish or aquatic invertebrates have been analyzed. Current methodology generally follows recent EPA guidance (USEPA 1995). Tissue contaminant data has also been obtained by means of State or private contractors. Typical contaminants monitored include PCBs, pesticides, and toxic metals, especially mercury. Monitoring data is available for the State's major rivers and many smaller streams. Much of the data was collected in reaction to known or suspected contamination problems.

From 1987 to 1991 monitoring of dioxin and dibenzofuran was conducted for fish tissue (as well as water, sediment, and soil) near resource recovery facilities as required by Section 22a-240 of the Connecticut General Statutes. During the period 1988 through 1994, fish tissue samples from wadeable streams across the State were obtained in cooperation with the CTDEP Fisheries Division, Stream Survey Project. A statewide survey of Mercury in fish tissue from sixty-one lakes and the Connecticut River was conducted by the University of Connecticut, Environmental Research Institute (ERI) in 1995 under contract with DEP (Neumann et al. 1996). A multi-state and EPA fish tissue contaminant survey was conducted on the main stem of the Connecticut River in 2000.

A follow-up study of mercury in lake fish is currently in progress and will again be conducted by contract with ERI. Sample collection is expected to begin in late summer 2005 and will continue through 2006. This project is supported by supplemental environmental penalty (SEP) funding. The plan is to repeat this study at approximately ten-year intervals to evaluate trends in mercury contamination.

Lake Monitoring

There are 2,267 lakes and ponds in Connecticut. Previous limnological surveys have focused on various subsets of approximately 120 lakes that were selected for study due to their potential for game fish habitat, public recreation, suspected pollution, or potential for acidification.

Historically, Connecticut has assessed 105 - 115 "significant" lakes statewide for 305(b) reporting. Significance is based on a lake having state or federal public access, or providing unique or otherwise important habitats. In incorporating previously listed 303(d) waters into the 305(b) assessment process in 2002, a number of lakes and ponds which are not considered "significant", but are believed to have impairments, were added to the lake assessment list. Additionally, lakes and ponds with locally monitored bathing beaches have been added.

Due to staff and funding constraints, there has been no statewide ambient lake-monitoring program in Connecticut for more than a decade, and many lake assessments fall into the "evaluated" category because existing information is more than five years old. However, there has been limited targeted monitoring by CT DEP and USGS staff in lakes with known problems. Also, the Lakes Management Grant Program, administered by CT DEP, funds intensive surveys and diagnostic studies in lakes identified as having special problems or special concern to communities. These studies provide valuable information regarding contamination, eutrophication, sedimentation, and extent of aquatic plant growth. Current beach closure data are also taken into consideration for determining primary contact use support.

CT DEP initiated a statewide probabilistic lake-monitoring program in 2005, whereby 60 lakes, chosen by a stratified random design, will be monitored over a three-year period (20 lakes/year) for trophic status. Resulting data will be incorporated into a statewide lake assessment for 305(b) reporting. Following completion of this project, CT DEP will evaluate the utility of this type of monitoring in providing lake assessment information and whether it is feasible to continue. This project is funded under Section 319. Assistance in probabilistic site selection was provided by the EPA Narragansett ORD Laboratory.

The EPA Region I OEME Laboratory has also begun a regional probabilistic lake monitoring program for a more comprehensive suite of indicators. The duration of this project is expected to be five or six years. CT DEP is currently working with EPA to determine future involvement in this project.

Intensive Water Quality Surveys

Intensive surveys are conducted to obtain data which provide a greater degree of spatial or temporal resolution than is generally obtained by routine fixed network or probabilistic monitoring sites. These surveys can include physical/chemical or biological monitoring and are sometimes program specific. They can be conducted to evaluate effectiveness of treatment facilities, calibrate water quality models or provide support to CWA section 319, 314, or TMDL projects. Intensive surveys are carried out in concert with rotational assessment schedules to the greatest extent possible. However, given the origin and nature of these projects a significant number may occur outside of the general rotation schedule. Details of specific intensive surveys are provided in annual workplans.

Physical/chemical

Intensive physical/chemical water quality surveys are conducted by the BWM to obtain chemical and physical data on selected water bodies during specific environmental conditions, or over an extended time period. These surveys may be conducted to determine compliance with water quality classifications, to verify or calibrate mathematical water quality models used for the establishment of wasteload allocations, and to evaluate the effects of pollution control measures. Often survey design calls for collecting a series of samples from multiple locations on a river segment, its tributaries, and wastewater discharges over a 24 or 48-hour period. Many intensive surveys are conducted on rivers that contain a relatively high percentage of treated wastewater, and take place during critical stress periods of minimal streamflow and elevated water temperatures.

The Monitoring program has recently acquired instruments with data-logging capabilities that can monitor and internally record field parameters over many days or months. Two main types are in use, multi-parameter units that monitor temperature, pH, dissolved oxygen, depth and conductivity. Four of these are in use, and can be deployed for periods of several days to weeks. In 2004 we acquired thirty units that monitor temperature only, these are used to monitor thermal maxima in selected rivers and are deployed for four to six months.

Biological

Intensive biological surveys can be described as biological monitoring activities outside of the fixed or rotating network of sampling sites, often requiring greater spatial or temporal resolution. This work can include assessment of resident aquatic communities, tissue contaminants, or toxicity testing of surface waters, effluents, or aquatic sediments.

State Park Beach Monitoring

The beach monitoring program has been conducted in cooperation with the CTDEP Parks Division and CTDPH, Environmental Health Section since 1990 to evaluate health risks and support beach closure decisions at state-owned and managed swimming areas. Beach monitoring for indicator bacteria is currently conducted by BWM personnel weekly at the 21 State owned beaches. Four beaches are located at State Parks along the coast of Long Island Sound, and 17 are located at inland State Parks. Sampling begins one week before Memorial Day and ends Labor Day week. Enterococci group bacteria are used as the indicator of sanitary quality for marine waters. *Escherichia coli* are used as the indicator of sanitary quality for fresh waters. All bacterial analyses are performed by the CTDPH Laboratory Division

Volunteer Monitoring

The Bureau of Water Management encourages volunteer monitoring by providing technical assistance and QA/QC support to volunteer monitoring projects and also by administration of Sec. 319 funded monitoring projects. The Bureau has incorporated quality assured volunteer monitoring data into the 305(b) assessment process since 1996. At the beginning of the Rotating Basin Strategy in 1997, a new staff position was added to the BWM, Ambient Monitoring and Assessment Section, to provide increased technical support to volunteer monitoring projects. A volunteer stream monitoring guidance document was developed and is directed at persons or groups interested in becoming involved in citizens monitoring

activities (Beauchene 2000). It is intended to encourage them to adopt a tiered approach. The tiered approach is designed to channel their activities in a way that will optimize the value of the information collected to DEP, while maintaining interest and enthusiasm on the part of the volunteers. A Rapid Biological Monitoring Protocol for Volunteers (RBV) was also developed and incorporated into the tiered approach (Beauchene and Hoffman 2000).
In the most recent Water Quality Report to Congress (CTDEP 2004b) volunteer monitoring data contributed to the assessment of 81 stream segments comprising 257 stream miles.

Technical Assistance and Review

In addition to actual monitoring activities, the Ambient Monitoring Section provides technical support to NPDES permitting functions related to power plant thermal discharges and intake structures subject to Section 316 of the Clean Water Act. This includes coordination of technical reviews with the DEP Fisheries Division. Support is also provided to the BWM, Permits and Enforcement Division, and Remediation Division of the Bureau of Waste Management by assisting with writing orders and permits, and subsequent review of monitoring proposals and reports. Technical support is also provided to the Watershed Management Section within the Planning and Standards Division for assistance in basin coordination and interstate pollution issues.

C. Plan for Comprehensive Coverage

As described in section II above, comprehensive assessment for the three primary designated uses and the major waterbody categories is a significant challenge given the magnitude and diversity of the waters in question, and the limited monitoring resources available. Our plan to accomplish this task relies on a combination of targeted and probabilistic monitoring projects conducted over an extended time period in an effort to overcome these resource constraints. Benthic invertebrate community assessment will remain the primary response indicator for assessment of ALUS in wadeable streams supplemented by fish community assessment and possibly periphyton. We plan to employ screening methods for benthic invertebrate monitoring as one mechanism to expand coverage. We will also evaluate the results of benthic methods comparison work that was done in concert with the NEWS project and National Wadeable Streams Assessment (WSA) project that should be completed by the end of 2005. And will consider other recent guidance (Barbour, et al 1999, Karr and Chu, 1999)

The utility of periphyton monitoring is currently being evaluated based on the two-year statewide probabilistic survey that was conducted in concert with the NEWS project.

An overview of indicators and monitoring program elements intended to determine use support for the three primary use support categories by resource type is presented in Table 4. A projected implementation schedule for the various monitoring program elements is presented in Table 5. As indicated in the projected schedule, the current year (2005) will serve as a transition period and an effort will be made to re-evaluate the strategy every three years. Existing targeted monitoring will continue along with further resolution of sampling schedules. The new rotating basin and probabilistic sequences will begin during the 2006 sampling season. Additional information is provided below by resource type.

Table 4. Comprehensive Assessment Approach by Designated Use

Aquatic Life Use Support			
Resource Type	**Exposure Indicators**	**Response Indicators**	**Monitoring Program Element**
Wadeable streams	Water column chemistry	Benthic Invertebrate community Fish community Periphyton (under evaluation)	Rotating basin, targeted index sites, fixed network and probabilistic
Lakes	Water column chemistry	phytoplankton, chlorophyll, macrophytes	Probabilistic and targeted
Large rivers	Water column chemistry	Fish community Benthic invertebrate community	Targeted sites
Contact Recreational-Use			
Resource Type	**Exposure Indicators**	**Response Indicators**	**Monitoring Program Element**
Designated bathing areas	Indicator bacteria Known sources of infectious material	N/A	Targeted sites at all beaches
Other waters	Indicator bacteria Known sources of infectious material Excessive weed growth	N/A	Fixed network, targeted, and probabilistic
Fish Consumption			
Resource Type	**Exposure Indicators**	**Response Indicators**	**Monitoring Program Element**
Wadeable Streams	Mercury, PCBs, Chlordane, emerging contaminants	N/A	Targeted and probabilistic
Lakes			Targeted
Large Rivers			Targeted

Table 5. Projected Implementation Schedule

Activity	Calendar Year																							
	05		06		07		08		09		10		11		12		13		14		15		16	
305(b) / 303(d) Report due			**X**				**X**				**X**				**X**				**X**				**X**	
Finalize Monitoring Strategy	X																							
Evaluate probabilistic (NEWS) data	X	X																						
Method development	X	X																						
Prepare 305(b) assessment		X	X			X	X			X	X			X	X			X	X			X	X	
Finalize work plan	X	X	X		X		X		X		X		X		X		X		X		X		X	
Review and update Monitoring Strategy	X						X						X						X					
Review SOP's and update as needed	X		X		X		X		X		X		X		X		X		X		X		X	
Wadeable streams																								
Rotating sites																								
biological communities				X		X		X		X		X				X		X		X		X		X
water chemistry				X		X		X		X		X				X		X		X		X		X
Probabilistic sites																								
biological communities				X		X		X		X		X				X		X		X		X		X
tissue contaminants				X		X		X		X		X				X		X		X		X		X
indicator bacteria				X		X		X		X		X		X		X		X		X		X		X
Targeted sites																								
water chemistry, ind. bacteria	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Large rivers																								
Rotating sites																								
fish tissue				X		X		X		X		X				X		X		X		X		X
benthic invertebrates																								
method development	X	X																						
sampling and analysis				X		X		X		X		X				X		X		X		X		X
Targeted sites																								
water chemistry, ind. bacteria	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
fish community assessment		X				X				X				X				X				X		
fish tissue (as needed)																								
Lakes																								
Probabilistic sites																								
CT trophic status survey		X		X		X																		
NE Lake & Pond Survey																								
Targeted sites																								
fish tissue		X		X																				X
trophic status		X		X		X		X		X		X		X		X		X		X		X		X
Designated bathing beaches																								
Targeted sites		X		X		X		X		X		X		X		X		X		X		X		X

Note
The horizontal bars shown in the above table for the rotating and probabilistic projects indicate sampling cycles that will result in statewide coverage. Vertical shading indicates years that require submission of 305(b) and 303 (d) reports. Each year is represented by two columns.

Wadeable Streams

Rotating sites

Biological communities

This is essentially a continuation of the previous Rotating Basin Strategy focusing on a network of integrator sites located in the lower reaches of Regional and key Sub-regional basins over a five-year rotation. Key response indicators are benthic and fish community structure (and possibly periphyton) to evaluate ALUS. Basic water chemistry and field parameters will also be measured. Completion of the five-year rotation will result in a state-wide targeted assessment of significant wadeable streams.

Probabilistic sites

Biological communities

Similar to above but based on a statewide probabilistic network sampled over a five year timeframe. We are currently consulting with EPA ORD for technical support in developing the sampling design. One unresolved issue is stratification by size category. Completion of the five-year rotation will result in a probabilistic statewide assessment of wadeable streams.

Tissue contaminants

Fish tissue screening for mercury, PCBs and pesticides collected during fish community sampling conducted for community assessment as described above. Completion of the five-year rotation will result in a probabilistic statewide assessment of tissue contaminant levels in wadeable streams.

Indicator bacteria

Statewide probabilistic design conducted over a two-year timeframe to provide a statewide assessment for each 305(b) reporting cycle.

Targeted sites

Water chemistry, indicator bacteria

These include the USGS cooperative network, intensive surveys, TMDL projects, etc.

Large Rivers

Rotating sites

Fish tissue

Representative sites sampled for tissue contaminants in sequence with the rotating basin schedule described above for wadeable streams. Completion of this project will allow for updating existing fish consumption advisories

Benthic invertebrates

Representative sites sampled in sequence with the rotating basin schedule described above for wadeable streams. The general lack of established methods for large river benthos presents a problem. Methods will be researched over the next year. Sampling will likely focus on dredge samples from natural substrates to develop species lists for representative river segments.

Targeted sites

Water chemistry, indicator bacteria

These include the USGS cooperative network, intensive surveys, TMDL projects, etc.

Lakes

Probabilistic sites

CT lakes survey

This is a three-year project based on a probabilistic design to examine the trophic status of CT lakes and ponds. It is funded under Sec. 319. Timeframe for field sampling is 2005 – 2007. Completion of this project will provide a statewide probabilistic assessment of trophic status for CT lakes. This project includes indicator development for algae and macrophytes.

New England Lakes and Pond Survey

This is a regional lakes monitoring project based on a probabilistic design that is being coordinated by the EPA Region I OEME Laboratory. Field sampling will begin in 2006. The level of participation by CT is currently being evaluated.

Targeted sites

Fish tissue

A survey of mercury in fish tissue from CT lakes will be conducted under contract with the University of CT. Field sampling will take place from 2005-2006. This project will update the 1995 data used to establish the statewide consumption advisory for mercury.

Trophic status

This work may involve nuisance complaints, evaluation of lake management projects, TMDLs, etc.

Designated bathing beaches

Targeted sites

State Park bathing beaches are sampled weekly for indicator bacteria during the bathing season. Sanitary surveys of tributary watersheds are also conducted as needed. This long-standing project is intended to verify the sanitary quality of bathing waters at CT State beaches. Since 2001 partial funding under the Federal "Beaches Environmental Assessment and Coastal Health Act of 2000" (BEACH Act) has supported this project.

Wetlands Assessment

Wetlands are vital and irreplaceable resources to the State of Connecticut. Wetlands provide significant habitats for fish and wildlife, and act as buffers between terrestrial and aquatic environments. The ability of these unique areas to moderate effects of flooding and drought, and to trap and filter sediments, nutrients and contaminants makes them essential to the protection of water quality and quantity throughout the State.

Connecticut contains approximately 450,000 acres of freshwater wetlands, as designated by soil type, and 17,500 acres of tidal wetlands (Table 6). Estimates of wetland loss since colonial times vary widely between authors. Metzler and Tiner (1992) contend that Connecticut has lost between a one third and one half of its original wetlands based on existing data and personal observation of land development across the State. Passage of the Connecticut Tidal Wetland Act in 1969 and the Inland Wetlands and Watercourses Act in 1972 greatly slowed the loss of wetlands in the State.

Table 6. Present and historical wetland and watercourse acreage in Connecticut.

Category	Acres	Percent of Total Acres
Connecticut total land area	3,116,130	100.0
Watercourses (excluding Long Island Sound)	86,496	2.8
Freshwater wetlands (by soil type)	451,656	14.5
Estimated original freshwater wetlands (1780s)	670,000 (Dahl 1990) - ~ 900,000 (Metzler & Tiner 1992)	21.5 – 28.9
Tidal wetlands	17,500	0.6
Estimated original tidal wetlands (1914)	23,360 (Goodwin & Niering 1966)	0.8

Many Connecticut wetlands are degraded by historic and ongoing activities. Tidal wetlands have been impacted by structures and practices that alter normal tidal flow, such as tide gates, undersized culverts, and of mosquito ditches. The damage caused by these activities has been successfully reversed by over 1,800 acres through restoration efforts. Stormwater runoff from developed lands may carry contaminants and sediments to tidal wetlands, interfere with the natural fresh/saltwater balance, and exacerbate the spread of the invasive reed grass, *Phragmites australis.* Freshwater wetlands are degraded by a variety of sources including direct discharges, sedimentation, and contaminated stormwater or groundwater. Ongoing and pending stormwater permit programs will help reduce the effects of stormwater on both fresh and tidal wetlands.

Inland Wetlands and Watercourses Management Program

In 1972, the Connecticut Legislature passed the Inland Wetlands and Watercourses Act (Connecticut General Statutes Sections 22a-36 through 22a-45), recognizing the benefits of these resources and providing for the regulation of activities affecting wetlands and watercourses. By this legislation, wetlands are defined as "land, including submerged land, which consists of the soil types designated as poorly drained, very poorly drained, alluvial and floodplain by the National Soil Survey of the USDA Natural Resource Conservation Service". Watercourses include "rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs and all other bodies of water, natural and artificial, vernal or intermittent…". Marshes, swamps, bogs and areas that meet the federal definition of wetlands are regarded as surface waters of the State and are accountable to Connecticut Water Quality Standards.

Municipal Jurisdiction: The CT DEP delegates jurisdiction over wetlands to municipal wetlands agencies who have adopted local regulations consistent with the State statutes and regulations. Local commissions may adopt additional or more stringent regulations, as well as provisions for regulating activities in upland review areas, so long as the language is consistent with State statutes.

Statewide Activity Reporting: CT DEP tracks wetland impacts reported by individual towns. The latest published data for 2002 show that 140 of the State's 170 inland wetland agencies reported issuance of 2,826 permits resulting in loss or alteration of 142 acres of wetlands, and alteration of 22,881 linear feet of stream. Non-reporting towns were issued reminders of reporting requirements but those subsequent data were not available at the time of this report.

401 Water Quality Certifications: The CT DEP, Bureau of Water Management, Inland Water Resources Division processes 401 Water Quality Certifications for proposed activities requiring U.S. Army Corps of Engineers 404 permits in inland water and wetlands. Section 401 of the Clean Water Act requires applicants to obtain a certification or waiver from the state water pollution control agency to discharge dredged or fill materials into waters or wetlands. The State agency reviews the proposed activity's compliance with State Water Quality Standards. The 401 Water Quality Certification discourages unnecessary, avoidable, or inappropriate uses of wetlands and watercourses. DEP staff currently review each 401 application on its individual merit, according to professional judgment and provisions of the Connecticut Water Quality Standards.

Monitoring of Inland Wetlands

While the CT DEP does not have a biological monitoring program for inland wetlands at this time, staff from Inland Water Resources Division attend meetings of the National and New England Biological Assessment of Wetlands Workgroups and are evaluating the pilot wetlands monitoring programs in other states. Through the Intergovernmental Mobility Program, CT DEP agreed to allow one staff person to work in Washington at US EPA headquarters on this effort. In the future when staffing resources permit, CT DEP hopes to implement its own wetland-monitoring program.

VI. Quality Assurance

The Department is committed to implementing a quality assurance system designed to ensure that all environmental data are scientifically valid, of known precision and accuracy, complete, representative, and legally defensible. The DEP quality assurance system will be maintained in accordance with applicable state and federal laws and rules, standards, guidance, contractual requirements, and sound management practices. The primary components of a quality assurance system include an organizational Quality Management Plan (CTDEP 2002b) and individual program Quality Assurance Project Plans (QAPPs). The CT DEP developed the Quality Management Plan as a means of documenting how it will plan, implement, and assess the effectiveness of quality assurance and quality control operations as applied to environmental programs funded by EPA. The Quality Management Plan is part of the mandatory EPA Quality System that requires all organizations performing work funded by EPA to develop and operate management processes and structures for assuring that data or information collected are of the needed and expected quality for their desired use.

Better documentation of quality assurance practices was identified as a goal of the previous ambient monitoring plan. The Ambient Monitoring Program has made considerable progress in accomplishing this goal since initiation of the previous monitoring strategy in 1997. Six QAPPs have been completed and approved, and three are in progress. The current status of QAPPs and other related documents is shown below in Table 7. In addition to the QAPPs listed below, eighteen QAPPs for volunteer or contracted monitoring projects were reviewed and approved over the same time frame.

SOP’s will be reviewed annually, and updated as needed.

Table 7. Quality Assurance Project Plan Status

Project	Project Specific/ Generic	Status
Ambient Biological Monitoring-Fish Community Structure, January 29, 2002	Generic	Final
Ambient Biological Monitoring – Periphyton Community Structure, July 2003	Specific	Final
Standard Operating Procedures Water Toxics Laboratory, 10 Clinton Street, Hartford, CT, February 24, 2000	Generic	Final
Indicator Bacteria Monitoring at State Owned/Managed Bathing Beaches, May 2003	Generic	Final
Naugatuck River Ambient Chronic Toxicity Project, September 2005	Specific	Final
Rapid Bioassessment in Wadeable Streams/Rivers by volunteers April 2003	Generic	Final
Ambient Biological Monitoring-Benthic Invertebrates, March 25, 1996	Generic	Final/Revising
Tissue Contaminant Monitoring	Generic	Drafting
Ambient Water Quality (Chemical/Physical)	Generic	Drafting
Probabilistic Monitoring of CT Lakes Spring 2005	Generic	Final

In addition to QAPP development, much of the recent progress in QA/QC has resulted from improvements in data management, which has produced significant corollary benefits for data quality. Some of the benefits resulting from use of a relational database are electronic logging of sample events and sample metadata. The database also facilitates review and analysis of QA samples like duplicates and field blanks, minimizes transcription error, and allows for value checking of laboratory results as well as overall sample tracking.

VII. Data Management

Efficient data management is essential to an effective monitoring program and has major implications for assessment, reporting, tracking, sharing data, and meeting data quality objectives. Electronic data management technology has greatly expanded our ability to manage, present, and share water quality information. It also represents a cost in terms of dedicated support staff with the specialized skills needed to obtain an optimum return on the significant investment in data management infrastructure.

Considerable progress has been made since implementation of the rotating basin strategy in 1997. At that time it became standard practice to collect locational data at all new ambient monitoring locations following EPA locational data standards. Most historical monitoring sites have been georeferenced as well. Two relational databases are currently in use for ambient monitoring.

A. Assessment Data

Assessment data (*e.g.*, segment descriptions, assessment methods, use-support, causes and sources of impairment) are stored electronically by waterbody segment in an Assessment Database (ADB) provided by the US EPA. This public domain software is used to manage assessment information to fulfill reporting requirements under sections 305(b) and 303(d) of the Clean Water Act. We have used previous versions of this software to manage assessment data since it became available as the Waterbody System (WBS) in 1988. Efforts are ongoing to link assessment information stored in the ADB directly to a Geographic Information System (GIS). Connecticut is part of a national initiative to index assessed surface waters to the National Hydrography Dataset (NHD). Problems related to incompatibility of map scales at the state and national levels have delayed utilization of the NHD in Connecticut. However, the NHD has recently been conflated to a 1:24,000 scale under a cooperative DEP/USGS project and indexing is currently in progress. The CT DEP expects to fully integrate the NHD into CWA reporting for the 2006 cycle.

B. Monitoring Results

For managing sample results, the Ambient Monitoring Program maintains an electronic data management system using Microsoft Access. This system is a relational database with referential integrity enforced. The purpose of the system is to store physical, chemical, and biological sampling results and the appropriate metadata with the intent to migrate data to EPA's national water quality database, STORET, which is accessible on the Internet. In-house development of the DEP monitoring database was strongly influenced by participation of DEP staff in the STORET modernization process during the early to mid 1990s. The entity relationship and metadata structure of the modernized STORET were replicated in the design process as much as possible.

All ambient data collected since implementation of the *Rotating Basin Strategy* beginning in 1997 resides in our Access database. Previously collected data have been stored in paper files, or in some cases using Statistical Analysis System (SAS), or spreadsheet software. Migration of this legacy data into the current Access database is being done in a prioritized sequence beginning with ambient biological data.

Access Database Description

The major data collection projects supported by the DEP data management system include the following:

- Ambient water quality data (results of physical/chemical analysis)
- Data for resident biological communities (benthos, fish, algae)
- Fish tissue contaminant data
- Indicator bacteria data at State-owned bathing areas
- NPDES outfall data (physical/chemical and toxicity)
- Externally generated water quality and biological community data (volunteer, consultant, academic, and USGS).

The monitoring database structure is described below. An entity relationship diagram is shown in Figure 4.

Data tables: These tables store metadata and result data. The heirarchy of these tables is as follows.

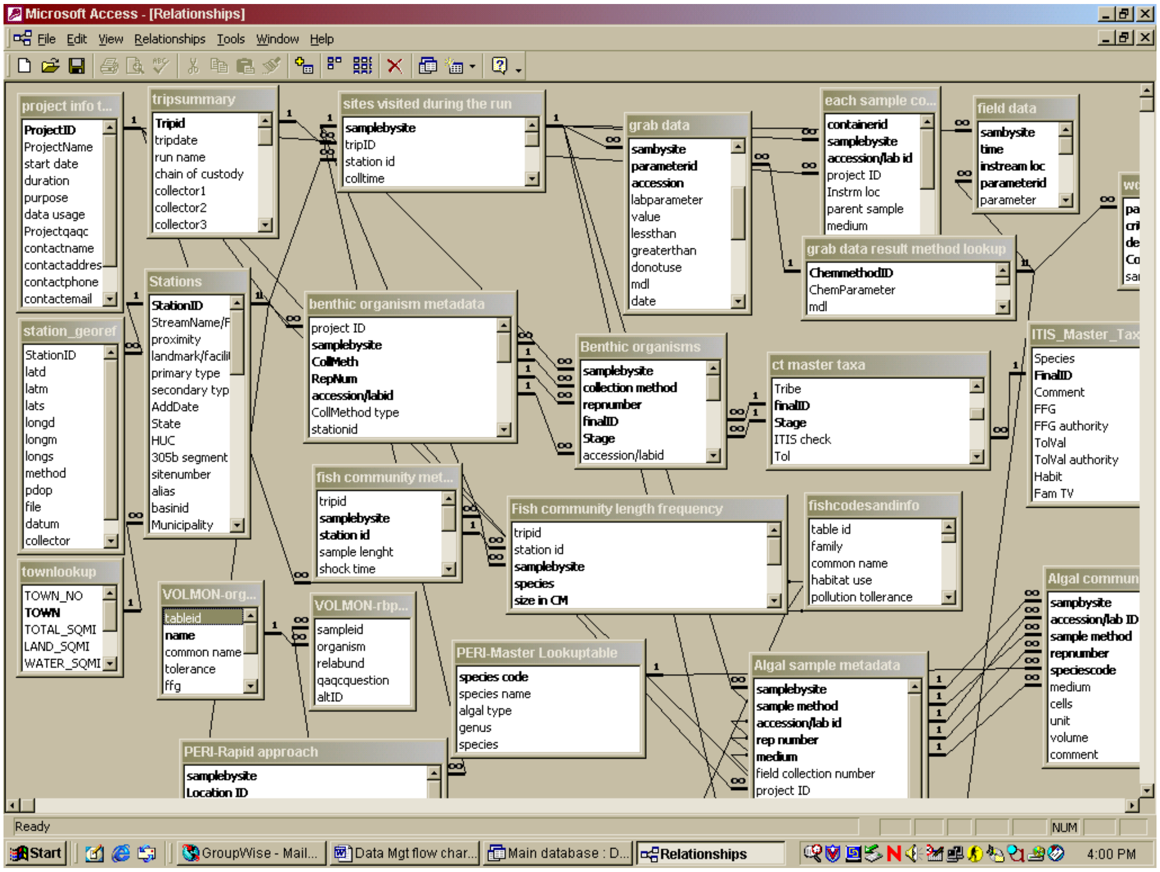
1.) Projects
2.) Trips
3.) Sites visited on the trip
4.) Samples collected at each site on the trip
5.) Results measured in the field from each site on the trip, and results determined by an analytical lab and reported to DEP.
6.) Station location metadata

Lookup tables: These tables store descriptive information about result data. The descriptive information is stored once but it may be related to many result occurances. Some examples are; pollution tolerance values, feeding groups, taxonomic hierarchy, analytical methods, citations, etc.

Database statistics: The following statistics are approximate as of spring 2005 and change frequently due to near daily addition of trips, samples and results.

- Period of Record: 10/1/1995 to present.
    - Pre-1995 data are currently being organized and structured for addition to the database.
- Sampling Trips: 1508
- Monitoring stations: 1578
- Samples:
    - Physical/Chemical = 18,500
    - Macroinvertebrate community structure = 1,292
    - Fish community structure = 250
        - *Link to DEP BNR Inland Fisheries Division = 1,200*
    - Periphyton community structure = 181
- Result records:
    - Physical/Chemical = 150,500
    - Macroinvertebrate community structure = 20,300
    - Fish community structure = 2,750
        - *Link to DEP BNR Inland Fisheries Division = 8,500*
    - Periphyton community structure = 2,633

Figure 4. Ambient Monitoring Database Entity Relationship Diagram



C. STORET

Data migration from the DEP Access database to STORET is a progressive, ongoing process and has been facilitated with contractor assistance provided by EPA Region I. During phase one, all available electronic data from the State beach monitoring project beginning in 1997 were migrated to STORET. Phase two will include ambient physical/chemical data and phase three will include biological data.

D. Data Management Plan

An Environmental Data Management Plan was developed to promote data quality and consistency, and encourage a maximum return on the investment in water quality data collection. It is included as Appendix B. This plan includes a policy that states in part: “All samples used to evaluate water quality collected by Ambient Monitoring and Assessment staff or provided to the Planning and Standards Division (PSD) from external sources will be stored and maintained in an electronic data management system. Samples and the resulting data collected by PSD staff are subject to appropriate metadata documentation by the PSD personnel responsible for the sample collection. Water quality assessments will only be made using data that meets minimum metadata requirements”

It contains additional descriptive information about database structure and metadata standards and currently serves as a user’s guide for monitoring staff. Eventually, this plan should also apply to data sources from outside of DEP.

E. Data Sharing

All assessment information is incorporated biannually into section 305(b) and 303(d) reports which are available in printed copy and are also available in electronic format on the Department website (http://www.dep.state.ct.us/). In addition, a brief summary document for the general public is routinely prepared. The long-term plan for availability of monitoring results and meta-data is full migration to STORET, which will provide access over the Internet. Currently, the monitoring results database is accessible to some DEP staff through the Department LAN. Requests for monitoring data from within or outside the Department are accommodated by the database manager.

VIII. Data Analysis and Assessment

The decision-making process for assessing the quality of surface waters for the 305(b) Report and 303(d) List is described in detail in the Connecticut *Consolidated Assessment and Listing Methodology for 305(b) and 303(d) Reporting – 2004* (CT CALM) (CTDEP 2004a). It is included as Appendix C. Assessment procedures generally follow guidance provided by US EPA (1997) using a variety of information and data types. The CT DEP applies a "weight of evidence" approach when using multiple types of data. A waterbody is generally considered impaired when one or more sources of data or information indicate a water quality standard is not attained, providing that information is considered sufficient and fully credible (as described in the CALM, p.6). For example, if available indicator bacteria data do not exceed criteria, but a CSO is present, the waterbody segment is considered impaired. If the benthic invertebrate community is just meeting standards, and the fish community shows impairment, the waterbody is considered impaired. In resolving discrepancies in conflicting information, consideration is given to data quality, age, frequency and site-specific environmental factors. If reconciliation of conflicting data is not possible, the waterbody segment is designated as "not assessed" for the relevant use and flagged for further monitoring.

A new approach to biological community assessment is currently under consideration in New England. CT is participating in a State/EPA workgroup to incorporate the Biological Condition Gradient / Tiered Aquatic Life Use concepts for assessment of wadeable stream data. A similar approach may be useful for large rivers and lakes.

We rely on monitoring programs of the Department of Public Health and the Department of Agriculture to generate data for assessment of shellfishing and water supply use support. This process is described in the CT CALM cited above.

IX. Reporting

A. General Reporting

The goal is to produce a written summary of all ambient monitoring projects soon after the raw data become available. Use of the ambient monitoring Access database facilitates documentation of metadata for all sampling results to maximize utility of monitoring data to secondary users within the DEP and outside. Data accessibility will also be increased by the use of STORET as the ultimate data repository by providing Internet access.

A preliminary assessment of aquatic invertebrate sampling results is prepared soon after sample collection is completed, usually by late winter following the previous fall sampling period. This preliminary assessment is based on field observations and is considered to be equivalent to RBP I (Plafkin, et al 1989). These results are circulated within the Planning Division and used to adjust the annual work plan for the remainder of the assessment cycle. A final assessment (RBP III) of the aquatic invertebrate data is conducted when laboratory analyses are completed, usually within one year of sample collection.

B. CWA Reporting

In accordance with Sections 305(b) and 303(d) of the CWA, the CT DEP submits a 305(b) Report and 303(d) List to the US EPA on even numbered years. The 305(b) Report provides information regarding the quality of all assessed waters in the State relative to their designated uses as established in the Connecticut *Water Quality Standards* (WQS) (CT DEP 2002a). The 303(d) List documents waters impaired for one or more designated uses. For waters impaired by a pollutant or pollutants, Section 303(d) further requires that a TMDL for identified pollutant(s) be established and allocated among dischargers.

As with many states, the Connecticut 305(b) Report and 303(d) List have historically been developed independently of each other, with some but not complete overlap of information. Despite their relationship, the statutory requirements for information gathering and public participation are slightly different for the two sections of the CWA. Starting in 2002, following a national effort to consolidate the methodologies for both sections, the Connecticut 303(d) List has been generated as a subset of waters assessed for the 305(b) Report. The CALM (CTDEP 2004a) describes how this is done. CT is committed to produce an integrated report that will identify all waters not meeting CWA goals regardless of the reason. It is our goal to establish priorities and remediation plans based on addressing both pollutant and non-pollutant causes of impairment. To understand this process, it is important to put it in the context of the Federal CWA and CT WQS.

The CWA is the primary federal law that protects our nation's surface waters, including lakes, rivers, and coastal areas. In authorizing the Act, the United States Congress declared as a national goal the attainment, wherever possible, of "water quality, which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water". This goal is popularly referred to as the "fishable / swimmable" requirement of the CWA. The State of Connecticut has adopted Water Quality Standards as required under Section 22a–426 of the Connecticut General Statutes and Section 303 of the CWA to accomplish this and other water quality goals.

The CT WQS (CT DEP 2002a) document contains policy statements concerning the protection of water quality and describes the Classification of State waters. Described for each Class are: 1) allowable discharges; 2) numeric or narrative criteria for various parameters, such as dissolved oxygen and indicator bacteria, to maintain water quality and; 3) designated uses that should be supported. For example, Class A surface waters have the following designated uses: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreational use; and water supply for industry and agriculture. The extent to which waterbodies support their designated uses is the key element of 305(b)/303(d) assessments. Designated use support is effectively the measure of water quality used for assessment.

All CWA act reports and supporting information (CALM, WQ Standards, etc.) are available in printed copy by request from the Planning and Standards Division. This information is also available in electronic format at the DEP website (http://www.dep.state.ct.us/).

X. Programmatic Evaluation

A. Annual Evaluations

The strategy will be re-evaluated on a broad scale every three years. Annual evaluations will be conducted at the Section and Division level to determine whether the implementation priorities of this strategy are being met at the beginning of each calendar year. These evaluations will focus on specific objectives identified in the annual work plan, and the completion status of each. The evaluation will also include assessment of available resources to support each of the program elements. Changing priorities and emerging problems should also be addressed. If deficiencies or new priorities are identified, they should be addressed by changes in the program. This process will also be reflected in regular PPA negotiations with EPA.

This evaluation should occur at several levels. Consideration should be given to whether the data collected identify a need for additional monitoring or other follow-up work. Laboratory audits conducted by EPA will also be considered in the evaluation, as well as a general review of all QA/QC sample performance.

B. Problem Areas and Data Gaps

Development of a comprehensive monitoring strategy requires that problem areas and data gaps be identified and addressed. Problem areas and deficiencies related to the ambient monitoring program are primarily dependent on two basic issues: available personnel resources; and the priorities that determine how those resources are applied to a wide variety of monitoring needs. Fortunately, a high degree of staff experience and expertise has somewhat compensated for limited resources in past years, and has carried the program through difficult periods. We realize that this is not an acceptable alternative to adequate resources and sound planning. The level of effort described for the work elements in this Comprehensive Ambient Monitoring Strategy depend on full utilization of existing staff resources and adequate funding of contracted support. Any reduction in existing staff levels would very likely result in failure to meet the projected goals.

C. Resources

The previous five-year rotating basin monitoring strategy was instrumental in the development of a more proactive approach to data acquisition and reporting. Historically, ambient monitoring activities have often been driven by the need to obtain data on short notice in response to real or perceived crises, or high profile issues. Acting in concert with limited staff resources, this condition resulted in reporting backlogs and the inability to adequately address long-term issues such as biocriteria development; refinement of sampling and assessment methodologies, and quality assurance practices. The rotating basin strategy and a modest increase in staff resources provided the foundation for a more robust planning and prioritization process. However, the demand for ambient monitoring information and associated support activities continues to exceed the capacity to meet this need at current staffing levels. Priority for additional resources should include funding of contract support for benthic and algae identification, fish community sampling, data migration to STORET, and analytical chemistry.

D. Data Management

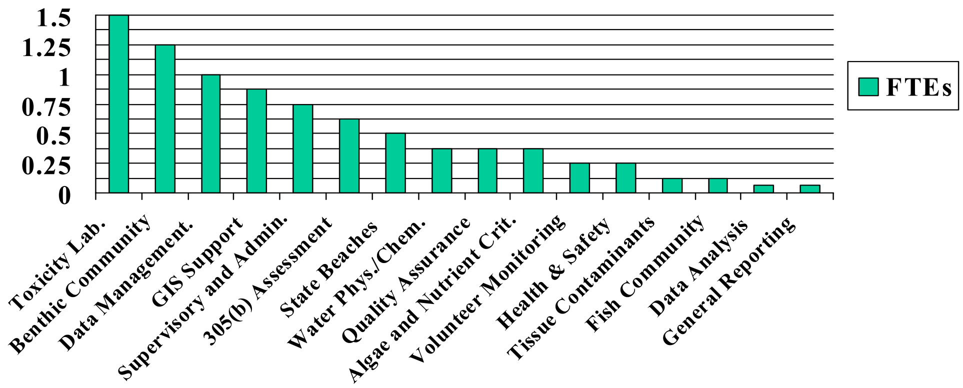
As discussed in Section VII above, data management is a key component of an effective monitoring program. The Ambient Monitoring Program has made significant progress in this area for the reasons stated above. These improvements in data management provide the necessary tools to support development of numerical biocriteria, refinement of assessment methodologies and reporting efficiency. However, at the existing staffing level we are still not fully able to utilize and benefit from the available data management resources due to the relatively large level of effort necessary just to adequately maintain the system. We recognize the need to institutionalize the data management process and as one potential means to accomplish this goal we are looking at the EPA Environmental Information Exchange Network as a possible funding source to provide professional data management support.

XI. General support and infrastructure planning

A. Staff

The ambient monitoring section is currently staffed by seven full-time employees, comprised of six environmental analysts, and one supervising environmental analyst. Full time staff are augmented seasonally by up to six temporary student employees. This results in an annual level of effort of approximately 8.5 full-time equivalents (FTEs). Approximate allocation of staff resources across sixteen monitoring project elements is shown in Figure 5. This staffing level is essentially unchanged since the previous monitoring strategy was written in 1999. However, staff turnover and program needs resulted in a slight shift of emphasis with respect to the level of effort assigned to several program elements. Two environmental analyst positions were lost; one person assigned to the benthic invertebrate laboratory and one person to the aquatic toxicity laboratory. Two analysts were hired, one primarily for 305(b)/303(d) reporting and management of assessment data, and one primarily to provide GIS support, a major component of which also supports 305(b)/303(d) reporting. CWA reporting was identified in the previous strategy as the most serious resource constraint related to ambient monitoring and these changes were in response to that problem. An outside contractor has been retained to provide support for benthic invertebrate taxonomy. Contractor support for invertebrate taxonomy will need to be institutionalized in order to maintain our existing level of ALUS assessment. Existing staff were shifted to cover the shortfall in the aquatic toxicity laboratory. While the overall level of effort for the aquatic toxicity laboratory was reduced from 2 to 1.5 FTEs, it still represents the largest allocation of staff resources for a single program element. A comprehensive internal evaluation of the costs and benefits of the laboratory relative to the strategic needs of the agency was completed in 2004, and Bureau management are currently assessing the various alternatives.

Figure 5.
Ambient Monitoring Section, approximate allocation of effort 2005
8.5 FTEs Total (7 Full-time, 1.5 Seasonal)



This strategy was designed to be implemented with currently available staff resources. However, potential for expansion of the program within existing resources is limited, and as described above, loss of one or more key staff would put successful implementation in jeopardy. Significant program expansion would require addition of a minimum of three FTEs for data management, quality assurance, data analysis and reporting. The approximate cost for the addition of three FTEs is $216,000 to $249,00. Additional funding for contract taxonomic support would also be needed at an estimated cost of $30,000 to $45,000.

B. Equipment

The Ambient Monitoring Program has adequate equipment to meet the needs of the program.

C. Infrastructure

The Ambient Monitoring Program occupies three locations in the Hartford area for office, laboratory and garage facilities. Office facilities are located at the main DEP office building at 79 Elm Street in Hartford. Laboratory facilities for benthic invertebrate work, aquatic toxicity testing, and a general area used for survey preparations and fish tissue processing are located at 10 Clinton Street, Hartford, in the CT Department of Public Health (CTDPH) laboratory building. These two buildings are located adjacent to one another and are connected by an enclosed walkway. Total floor space is approximately 3,700 square feet. All laboratory areas contain sinks and the general area contains two fume hoods.

Large equipment, boats, and vehicles are located in a third building at 9 Windsor Avenue, Windsor. This site is used to garage three boats and trailers, a large van used as a mobile laboratory, a canoe, outboard motors, fuel and related equipment. We also share a small laboratory room at this site with the Long Island Sound Monitoring Program. We use this room primarily for storage. The Long Island Sound Monitoring Program uses it as a survey preparation area. It contains a fume hood and sink. All laboratory space complies with OSHA safety requirements. Laboratory space allocation is shown in Table 8.

Table 8. Current laboratory space, Ambient Monitoring Program

Type of space (sq. ft.)	Laboratory	Office	Storage	Refrigerated	Misc.
10 Clinton Street					
Benthic Lab.	697	88	30	24	N/A
Chemistry room	534	none	30	24	N/A
Fish preparation	529	81	87	59	N/A
Aquatic Toxicity Lab.	1,265	90	none	86	N/A
Break room					82
Totals	**3025**	**259**	**147**	**193**	**82**
9 Windsor Ave.					
Chemistry room	600	none	none	none	none
Totals	**600**				

Laboratory space is currently adequate to meet the basic needs of the program. However, there are drawbacks associated with the logistics of using separate facilities. The location of the Windsor Avenue garage facility can add significantly to travel time for any fieldwork requiring the use of a boat. Environmental conditions in the CTDPH laboratory are often problematic relative to operating an aquatic toxicity laboratory, particularly due to fluctuations in ambient room temperature.

There is a large element of uncertainty concerning the future of our laboratory space at 10 Clinton Street. The DPH Laboratory is planning to relocate to a new facility outside of Hartford within the next five years and the current location will be demolished or renovated. In either case the DEP laboratory will be moved, possibly to the new DPH facility. It is likely that a new laboratory location away from the main DEP office at 79 Elm Street will be even less logistically favorable than the current situation. There is significant potential for diminished logistical efficiency to result in reduced monitoring activity given the same level of effort.

XII. Summary

The *Connecticut Comprehensive Ambient Water Quality Monitoring Strategy* presents a plan to monitor all State waters over a ten-year time period as required under Section 106(e)(l) of the Clean Water Act. To accomplish our monitoring objectives, this strategy we will employ a combination of targeted and probabilistic monitoring designs over an extended time period. This approach will provide answers to waterbody specific questions essential to the Department's water resource management activities and also provide the comprehensive assessment capability required by EPA. The Strategy describes core and supplemental water quality indicators for assessing primary use support categories. Historical monitoring approaches are discussed. An implementation schedule is presented for the various monitoring activities directed at rivers, lakes, bathing beaches, wetlands and estuaries. Monitoring support functions like quality assurance, data management, analysis, and reporting are also discussed.

The proposed strategy will require full utilization of the limited staff resources available for ambient monitoring. It also identifies areas where the program would benefit most from additional resources if available.

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Appendix A

Connecticut Comprehensive Water Quality Monitoring Strategy for Long Island Sound and its Embayments

July 2005

LONG ISLAND SOUND

Introduction

In 1994, the Long Island Sound Study (LISS) in which the Connecticut Department of Environmental Protection (CT DEP) is a policy level partner, released "A Monitoring Plan for Long Island Sound" (LISS Plan). The LISS Plan incorporates many of the needs for ambient monitoring and assessment of Connecticut's 700 mi^2 of estuarine waters comprising coastal harbors and embayments as well as the greater Long Island Sound (LIS) and Fisher's Island Sound (FIS). The LISS set as a goal for their monitoring strategy "to protect and improve the water quality of Long Island Sound and its coves and estuaries" for the purpose of identifying "impairment and environmental or health risk issues (effects) that can be related to specific, manageable sources (causes)." This is not inconsistent with the federal Clean Water Act (CWA) delegation of program responsibility to the states by the Environmental Protection Agency (EPA) to meet the 10 major elements of an approvable monitoring assessment program articulated by EPA (2003).

The LISS (LISS, 1994) identified four major monitoring "tracks" relevant to a comprehensive monitoring approach to assess LIS waters – Nutrients, Living Resources, Toxic Substances and Pathogens. The LISS Plan also included two additional elements of value to a complete approach – Citizen's Monitoring and Data and Information Management. As the LISS Plan was implemented, there were clear successes in the area of Nutrients for which the LISS has financed a large proportion of the effort, and for Pathogens and Living Marine Resources, which are monitored through other funding and programmatic sources but meet most LISS Plan needs. Toxic Substances have not been as consistently monitored within LISS by CTDEP or through other ongoing programs but are subject to aggressive source control and permitting programs. Monitoring data indicate that their significance as an impairment has been greatly reduced, which has allowed more focused assessments of sediment hot spots and tissue levels that exceed human health thresholds. Citizen involvement has been spotty, mostly focused on cultural eutrophication or living resources, and a comprehensive LIS database has been elusive. Most active monitoring efforts have program specific data management requirements that house the data in modern databases available upon request. LISS is also funding the University of Connecticut to compile existing monitoring data during the next year.

CT DEP has also been a participant in the EPA's National Coastal Assessment since its initiation under "Coastal 2000". That program has helped fill some of the monitoring gaps in the LISS effort, particularly in nearshore areas and non-nutrient parameters such as toxic substances in sediments and tissues, sediment toxicity, and benthic community integrity. CT DEP also relies on monitoring conducted for pathogen indicators as part of shellfish management program of the Department of Agriculture's Aquaculture Bureau, and the CT Department of Health Services and municipalities for bathing beaches.

More recently, CT DEP has gained EPA and National Oceanic and Atmospheric Administration (NOAA) approval for its Coastal Zone Act Reauthorization Amendments (CZARA) Section 6217 Coastal Nonpoint Pollution Control Program (CNPCP). The

CNPCP describes state monitoring efforts that both parallels many of the issues in the LISS Plan, but also adds a watershed component because of its focus that strengthens the monitoring links between upland areas and LIS. While the CNPCP monitoring plan does not require or propose any new field effort, it does propose a mechanism for relating and interpreting many of the ongoing efforts. This will be accomplished through tracking and modeling enhancements, to ensure CNPCP objectives for monitoring and tracking are met without redundancy of effort. Use of monitoring pressure – state – response components is incorporated in the CNPCP monitoring and tracking approach.

The Department intends to fully implement a monitoring program that meets all objectives established in EPA monitoring guidance and programs like the LISS and the CNPCP. Funding availability is a prime determinant of success, and priorities based on environmental and human health needs are in constant flux. Nevertheless, CT DEP has been able to do a reasonably effective job of monitoring and assessing the health of LIS and the sources that contribute to its problems by assigning priorities to programs and efforts that provide as comprehensive a coverage as possible. Long Island Sound Nutrients and Hypoxia monitoring provide a good example of a collaborative effort that includes participation by CT DEP's Bureau of Water Management and Marine Fisheries Program, New York City's Department of Environmental Protection (NYSDEP), the Interstate Environmental Commission (IEC), university researchers, and citizen volunteer programs through a coordinating umbrella of the LISS. Those efforts were further enhanced by EPA's National Coastal Assessment, which brings CT DEP into harbors, tidal rivers and embayments and adds an effort by Stony Brook University in nearshore areas of LIS waters in New York. Universities have also added ferry monitoring programs in the last two years and a Long Island Sound Integrated Coastal Observing System (LISICOS) that has promise to expand the MySound continuous monitoring system of the University of Connecticut at Avery Point. These are just a few of the contributing efforts that are help complete the monitoring picture, but may be ephemeral in nature.

In sum, the LISS Plan acknowledges the reality of fluctuating budgets and fostered a "minimalist" approach to try to ensure consistent, long-term data were obtained in the most cost-effective manner that answered basic questions on the health and status of LIS waters and resources. The success of this approach in cobbling together adequate data to answer those questions is probably best exemplified by the LIS Indicators that are updated regularly and published biannually in a "State of the Sound" report. While more than 50 indicators are tracked, the "State of the Sound" report usually reports on a relatively few in an attempt to capture public interest on hot topic issues and aspects of LIS that are most relevant to the public user. The indicators selected by the LISS do not represent the full suite of potential environmental indicators that could be tracked, but are testimony to the availability of quality monitoring data that allows continuation of this important assessment and outreach tool.

Monitoring Program Strategy

As reflected in the introduction, we are pursuing a basic strategy that incorporates the major monitoring programs in the Sound (state or status indicators) as well as some of the relevant source relationships in the watershed (pressure indicators). The LISS Plan provides a basic strategy for monitoring, tracking and assessing LIS that will be incorporated into this program description to meet the requirements of the remaining nine elements. The strategy is built around the four primary tracks of Nutrients, Living Resources, Toxic Substances and Pathogens identified in the LISS Plan. Tables 1-4 categorize the primary pressure and state indicators where monitoring is essential, and generally indicates the status of relevant monitoring activities. Tables 1 – 4 expand the LIS monitoring strategy beyond the LISS plan to encompass the full range of monitoring needs and activities relevant to LIS, required for reporting (e.g., 305(b) assessments) and the interrelationships of many state and federal programs that require monitoring and tracking and help provide as complete an assessment of LIS is possible.

Monitoring Objectives

Monitoring objectives are related to specific assessment, reporting and tracking needs of state and federal programs, many of which have been identified above. Prominent among these are: 305(b) assessments and reporting; 303(d) impaired water listing; CALM; TMDL implementation tracking; Long Island Sound Study; Nitrogen Trading; CWA Section 319 NPS program; and CZARA Section 6217 CNPCP. These objectives and activities consolidate the recommendations of these programs, including the LISS monitoring plan that relates to ambient monitoring needs. Monitoring objectives, however, are best framed within the four categories of Nutrients, Pathogens, Living Resources and Toxic Substances, introduced above, which comprehensively cover the programmatic domain of monitoring needs.

I. Nutrients

1. Map the areal extent and duration of hypoxia in LIS bottom waters each summer to determine trends and efficacy of nitrogen control programs (LISS priority)
2. Profile sediments every 3-5 years in hypoxic areas to ascertain severity of hypoxia and its relationship to sediment quality
3. Monitor nutrient distribution in LIS waters to track programmatic reductions and changes in the Sound (LISS priority)
4. Monitor phytoplankton abundance and character in the Sound to determine changes related to the severity of hypoxia and the effects of nitrogen control (LISS priority)
5. Monitor sources of nitrogen throughout Connecticut to develop primary source and delivery relationships that can be used to calibrate watershed models, track changes, and verify surrogate indicators such as land cover character (LISS priority)

II. Pathogens

1. Monitor and track indicator organisms at state and local bathing beaches to assure bather safety from exposure to pathogens (LISS priority)
2. Monitor and track indicator organisms at commercial and recreational shellfish beds to assure shellfish products are safe for human consumption (LISS priority)
3. In areas with chronic indicator effects, investigate sources through trackdown surveys and TMDL development (LISS desirable addition)

III. Toxic Substances

1. Periodically survey and/or assemble sediment contaminant data to identify areas where toxic substances exceed environmentally acceptable concentrations (LISS priority)
2. Periodically survey and/or assemble seafood contaminant data in representative species to identify potential human health risk concerns (LISS priority)
3. In areas of known or suspected contamination, assess impacts on living resources using toxicity or biomarker techniques (LISS research and development)
4. In areas of known or suspected contamination, evaluate active contributing sources and historical sinks (LISS priority)
5. Investigate through survey or monitoring emerging issues such as endocrine disruption causes and consequences or effects of polybrominated diphenyl ether (PBDE)

IV. Living Resources

1. Monitor status of LIS open waters through annual finfish trawl surveys (LISS priority)
2. Monitor status of LIS coves, harbors and embayments through annual sampling using seines or other appropriate nearshore sampling gear (LISS priority)
3. Monitor benthos of LIS annually and interpret benthic health using biocriteria relevant to the Sound (LISS priority)
4. Monitor phytoplankton abundance and diversity in LIS open waters and harmful algal blooms in nearshore habitats (LISS priority)
5. Monitor eelgrass distribution and abundance at least biannually to track status and health of eelgrass
6. Use condition of fish, benthos, phytoplankton and eelgrass to assess effects of nutrient, toxic substance and pathogen stressors on living resources and ecosystems (LISS research and development)

Monitoring Design

CT DEP conducts or participates in monitoring activities that meet many of the objectives listed above, and has access to data from all the supplementary programs conducted by other entities identified herein. The LISS funds 17 nutrient stations sampled on a monthly basis, plus addition "hypoxia" surveys at up to 30 additional stations during the June through September period (Figure 1). The NCA-funded studies take a probabilistic approach, and stations are adjusted periodically to provide statistical certainty of data analysis in both offshore and nearshore regimes (Figure 2).

Nutrients and hypoxia effects are fully assessed in offshore areas and most nearshore areas (Table 5). Toxic contaminants, because they reside in sediments and conditions are slow to change, do not require frequent monitoring and most problematic contaminants are well studied in most of the Sound. Pathogens are regularly monitored for bathing and shellfish safety purposes and living resources of commercial value are regularly assessed (Table 5). There are some relatively recent activities that will help CT DEP meet monitoring objectives particularly in the areas of benthos, toxicity, and tissue contamination through the NCA and eelgrass beds through the LISS in cooperation with the Fish & Wildlife Service. Biomarkers and emerging toxic effects such as endocrine disruptors and PBDE are currently not addressed.

Programs that are fully implemented (Table 5) have either defined and approved designs through EPA accepted Quality Assurance Project Plans (QAPPs) as in the nutrient surveys, or are part of long standing state sampling programs funded and/or approved by federal agencies, such as the Interstate Shellfish Sanitation Conference (ISSC) protocols for shellfish indicator monitoring of the Food and Drug Administration and the fish trawl surveys and nearshore seine surveys conducted under an approved workplan and funded through the Federal Aid in Sport Fish Restoration (Wallop Breaux) program funds (Table 6).

Partially implemented programs generally have monitoring designs of the caliber noted above (QAPPs or other federal concurrence) for the portion implemented, but do not always have specific designs for the portions required that would bring their scope up to full implementation, or certain long-term funding. It is the intent of CTDEP, however, to continue monitoring programs essential to the comprehensive monitoring scope presented herein, especially the National Coastal Assessment activities that have filled many of the monitoring gaps. Specific shortcomings that must be addressed through program revision and expansion are:

III.1. - Sediments are not comprehensively sampled on a regular basis for contaminants, but data are available from other programs such as dredged material management or from special surveys. Since 2000, CT DEP has participated in the EPA's National Coastal Assessment (NCA), which has provided regular sampling of sediment quality in a probabilistic manner, under an approved EPA QAPP. The NCA is designed to provide an overall assessment of conditions by random selection of sampling points at an intensity that provides statistical certainty to the outcome.

IV.3. – Benthic monitoring of invertebrates is conducted by CT DEP under the NCA but LIS-specific biocriteria should be evaluated. This is a long-term goal, and a likely priority for research in the LISS research agenda under development. As for sediments, while the NCA program's probabilistic approach does not provide complete geographic coverage, it does lend statistical certainty to its design for an overall assessment.

IV.4. – Phytoplankton is monitored offshore under an EPA-approved QAPP, and now includes use of phytopigments to provide more comprehensive evaluation in a less time intensive manner, meeting CTDEP assessment needs. The Connecticut Department of Agriculture's Bureau of Aquaculture (DA/BA) conducts some nearshore monitoring of toxic algae that may render shellfish toxic to human consumers, but more comprehensive monitoring of potentially harmful algal blooms may be warranted, or at least a more organized response to emerging HAB conditions.

IV.6. – As noted above, fish, phytoplankton and eelgrass monitoring is continuing, and regular monitoring of benthos has been implemented through NCA. As noted above for general benthic health (IV.3), there is a need to research and develop biocriteria for LIS benthos for a complete benthos-monitoring program. The NCA program, which CT

DEP participates in, has provided benthic invertebrate analyses since 2000 in a probabilistic manner, and should meet assessment needs once appropriate evaluation criteria are adopted.

Core and Supplemental Water Quality Indicators

Through the LISS, CT DEP helps develop both core and supplemental water quality indicators that are derived primarily from the water, biological and habitat monitoring efforts described above. These indicators, which number more than 50 as noted in the Introduction, are available through the LISS website at:
http://www.longislandsoundstudy.net/indicators/index.htm
While these indicators, in many cases, provide intuitive insight into the health of LIS, the LISS treats their interpretation cautiously since the relationship between organism and ecosystem effects and their causes are generally not well understood. Consequently, management actions are often taken on the basis of chemical impairments defined by exceeded water quality standards and criteria, i.e. these are the core indicators. Core and supplemental indicators are specified in Table 2 of the main report for Connecticut's marine waters, although many other sampling parameters and indicators are relevant to LIS assessments and management actions. For example, dissolved oxygen (DO) has been readily measured in LIS and found not to meet state water quality criteria. The problem was linked to excess nitrogen and carbon loads, and a TMDL developed to meet state DO criteria by 2014. While winter flounder provide a more charismatic indicator, it is supplementary in nature. Winter flounder have been in decline for several years and the causes are more complex making a direct link to a water quality problem, such as low DO, speculative.

While a large suite of indicators is evaluated by CTDEP, including biological indicators, and will continue to be assessed by CTDEP as overall indicators of health, they currently do not lend themselves to defining water quality management actions because the state of that understanding is uncertain. CTDEP will continue to assess the link to actions that may be taken based on this comprehensive indicator tracking effort and incorporate change when warranted. Until ecosystem, population and even organism effects are better understood and can be related to specific pollutant and habitat management needs, these indicators can only provide a general sense that a problem exists in LIS. To be useful, additional research is required, which is not likely to be accomplished over the short term. Therefore, while the living resource monitoring described above may suggest a water quality problem, it's usually violations of numeric criteria that are identified impairments under 305(b) and 303(d) protocols and lead to management action through TMDLs or other remediation. As the state of the science, and use of indicators, improves, biological indicators will hold more promise. For example, eelgrass demise may be related to excess nitrogen loading and a direct link to a management action, e.g., nitrogen control, can be made provided numeric criteria are available that define acceptable nitrogen concentrations or loads that protect eelgrass bed health.

In this LIS monitoring strategy, some potential advances in the use of indicators are proposed including the use of eelgrass, a benthic invertebrate index, and biomarkers. These are raised in the appropriate portions of the strategy, and should be considered supplemental indicators at this time. Priorities and time frames are included for these proposed additions. In some cases, the monitoring has been implemented, but there are interpretive uncertainties that must be addressed, as noted above.

Quality Assurance

All CT DEP monitoring funded or partially funded by EPA requires an EPA-approved QAPP that satisfies expert reviewers that monitoring project objectives, methodologies, data interpretation, and final decisions are sound (Table 6). The predominant monitoring activities conducted by CT DEP are under approved QAPPs, i.e., the nutrient/hypoxia surveys and NCA sampling. Many other activities fall under QAPP approval, e.g., work conducted by area universities funded by the LISS or other EPA-related sources. Further, since all four key areas of monitoring that meet state monitoring needs for LIS were developed through an expert panel approach sponsored by the LISS, their focus and design have been reviewed and attained expert consensus prior to actual implementation of monitoring activity. That consensus is articulated in the LISS Monitoring Plan (LISS, 1994) and formed the fundamental monitoring design that gained further approval through the EPA QAPP process.

Data Management

Although CT DEP maintains an effective database for the nutrient monitoring program that is available to and regularly requested by researchers and regulators, incorporation into a national database has been elusive except for the NCA sampling (Table 7). Data from other sampling that is not conducted directly by CT DEP, e.g., sediment contamination data for dredging, fish trawl data, and DA/BA shellfish sanitation sampling, is housed in agency databases. It is a goal of CT DEP to incorporate all LIS field data collected under EPA grants into STORET in the next few years, but at present CT DEP has no plans to assemble data from non-Water Bureau programs identified herein for incorporation into STORET. That effort would require special funding and dedicated staff on a continuing basis. The LISS has funded the University of Connecticut to comprehensively compile and evaluate a broader dataset for LIS, which may provide a start in that direction.

Data Analysis/Assessment

The most regular and consistent analysis of LIS data is conducted on a biennial basis as required for CWA Section 305(b) reporting and is described in CT DEP reports to EPA. Because impairments are specifically defined as exceeded water quality criteria, the most prominent issues in LIS are hypoxia, beach and shellfish closures, and contaminated sediments. The present monitoring efforts have proven adequate to those needs. In addition, EPA analyzes NCA data and reports results periodically in National Coastal Condition Reports. The LISS 2002 grant to review and analyze available water quality and biological data for LIS (noted above) will provide the first comprehensive review and analysis in more than 10 years since the Comprehensive Conservation and Management Plan (CCMP) was issued in 1994. Also, as identified above, the LISS indicator assessments and tracking provide a more public-friendly interpretation of LIS health and trends.

Reporting

The primary reporting mechanisms for LIS data are the 305(b), 303(d) and CALM reports required by EPA. CT DEP has also produced a monitoring report on hypoxia (CT DEP, 2000), has a nutrient report in draft, and produces periodic fact sheets and regularly updates their website with hypoxia maps (http://www.dep.state.ct.us/wtr/lis/monitoring/monsum.htm). CT DEP further interprets and reports findings through the LISS indicators web site identified above, and through periodic "Sound Health" publications (LISS, 2001; 2003) that focus on a subset of the entire suite of indicators. The National Coastal Condition Reports also provide an outlet for LIS data (EPA, 2001; 2004), and are produced by the EPA.

Programmatic Evaluation

The LIS monitoring program is programmatically evaluated in essentially the same manner as described in the main body of the text, Section X. Variants are summarized below.

A. Annual Evaluations

In addition to the reviews provided for CTDEP's comprehensive monitoring program, LIS activities come under additional scrutiny through the LISS and NCA processes. The data collected are related to those program's goals and objectives and needs for additional monitoring, adjustments, research, or other work are identified. Field and laboratory reviews and audits may be conducted by the EPA and are considered in these evaluations, as well as the continuing QAPP performance and compliance requirements that are quite comprehensive.

B. Problem Areas and Data Gaps

The LIS comprehensive monitoring strategy regularly reviews problem areas and identifies data gaps, both in house and through the LISS's Scientific and Technical Advisory Committee. As with inland/freshwater monitoring deficiencies are often related to available personnel resources and the priorities that are assigned to the wide range of monitoring needs within the comprehensive LIS strategy. Fortunately, most needs are being met and recommended needs are in many cases still under development (e.g., benthic indices, biomarkers, endocrine disrupters, etc.). Both LISS research and state research programs (e.g., the License Plate Fund) are often targeted to meet these needs so a transition from research to monitoring can progress. Reductions in staff level or supporting funds are a major concern that can lead to failure to meet monitoring goals.

C. Resources

The CTDEP LIS monitoring program sets a high priority on data completeness and has a superb record for collecting samples according to schedule at the designated sampling stations. Without that level of commitment to procure samples, there is little value to subsequent data management, interpretation and reporting objectives. Hence, staff activities are focused on sampling, analysis and data security. This condition has often resulted in reporting backlogs and the inability to adequately address long-term issues such as biocriteria development; refinement of sampling and assessment methodologies, and program expansion into new indicators. Priority for additional resources should include funding of in house and/or contract support for benthos and algae identification and interpretation and other new indicators identified above, data migration to STORET, and data analysis, reporting and dissemination.

D. Data Management

The LIS Monitoring Program has proven competence in data quality, storage and management, but recognizes the need and value of securing data into STORET. This would allow broader access to the data and facilitate its distribution for research and developing new approaches such as numerical biocriteria, refinement of assessment methodologies, new indicators, and reporting efficiency. However, at the existing staffing level we are not fully able to utilize and benefit from available data management resources while maintaining a robust field, laboratory and data storage program as the top priority.

General support and infrastructure planning

A. Staff

The LIS monitoring program has two full-time employees and one half time employee within the Water Bureau, and is overseen by one supervisor accounting for about 33% of his time. CTDEP's Marine Fisheries Unit provides a boat captain and engineer in the field to operate boats. Laboratory analyses are contracted out, primarily to the University of Connecticut's Environmental Research Institute. One or two temporary student employees seasonally augment full time staff. This results in an annual level of effort of approximately 4.0 full-time equivalents (FTEs), exclusive of laboratory work. The Program could easily utilize an addition of two FTEs to expand the program into identified priority areas and for data management, quality assurance, data analysis and reporting.

B. Equipment

The LIS Monitoring Program has adequate equipment to meet its needs.

C. Infrastructure

The LIS Monitoring Program occupies three locations in the Hartford area for office, laboratory and garage facilities and at the Old Lyme facility. Office facilities are located at the main DEP office building at 79 Elm Street in Hartford. Laboratory facilities for phytoplankton/phytopigment work and other occasional needs such as fish tissue processing are located at 10 Clinton Street, Hartford, in

the CT Department of Public Health (CTDPH) laboratory building. These two buildings are located adjacent to one another and are connected by an enclosed walkway. Total floor space is approximately 3,700 square feet. All laboratory areas contain sinks and the general area contains two fume hoods.
Large equipment, vehicles and some supplies are housed in a third building at 9 Windsor Avenue, Windsor when not in the field. The space is used as a survey preparation area and contains a fume hood and sink. All laboratory space complies with OSHA safety requirements. Equipment and supplies are also occasionally stored at Old Lyme, particularly during the busy season, either in the boat house or on board the R/V *Dempsey*. Facilities currently are adequate to meet the basic needs of the program. Analytical facilities are located in Mansfield at the University of Connecticut's Environmental Research Institute. Specialized samples are sometimes sent to other contract labs or University of Connecticut researchers with expertise in the area of interest. Logistically, the program requires a lot of travel because of the size of the Sound, dock locations, and location of the analytical lab and Hartford base, both distant from the Sound.

LONG ISLAND SOUND TABLES

Table 1.

NUTRIENTS – State Indicators						
Medium	Location	Status*	Primary	Ancillary	Priority/ Certainty **	Research
Estuarine Water	Offshore LIS	Continuing, Fixed Stations	DO, Chl a, N, P, C, Si, PAR, Secchi	Temp, Depth, Salinity, TSS	High/ Good	Primary Productivity; Photopigment
	Inshore LIS	Continuing, NCA, Probabilistic, Funded 2006	DO, Chl a, N, P, C, Si, PAR, Secchi	Temp, Depth, Salinity, TSS	High/ Fair	Photopigment
Estuarine Sediments	Offshore LIS	Intermediate, Occasional, NCA, Funded 2006	Remots Sediment Profiles of RPD (Redox Potential Discontinuity)		Medium/ Low	Nutrient cycling, regeneration from sediments, SOD
NUTRIENTS- Pressure Indicators						
Medium	Location	Status	Primary	Ancillary	Priority/ Certainty	Research
Surface Water (see freshwater)	Tributary Rivers	Continuing, Fixed Stations	N, P, C, Si	Flow Volume	High/ Good	
Groundwater	Niantic River and Broad Brook	Long-term need	N, P	Hydrol-ogy	Low/ Poor	Research Effort
Point Sources (NPDES)	Statewide	Continuing, Permit Require-ment	N	Flow Volume	High/ Good	
NPS/Stormwater (NPDES)	Statewide – SPARROW, CTWM (HSP-F), AVGWLF	Continuing, Models, Calibrated to base years	N, P, C	Flow Volume	High/ Good	
Land Cover	Statewide	Continuing, UConn's CLEAR, 1985, 1990, 1995, 2002	Land Cover Categories	Impervious Surface	High/ Good	
Atmospheric Deposition	Statewide	Discontinued, 1997-2002	N – wet and dry	Rainfall, pH, major cations	Medium/ Poor	

* Immediate = as soon as funding can be found; Intermediate = 3-5 years; Long-term = 5-10 years.
** Priority reflects the importance of continuing or adding the component; Certainty reflects the prospects for continued or new funding.

Table 2.

PATHOGENS – State Indicators						
Medium	Location	Status*	Primary	Ancillary	Priority/ Certainty**	Research
Estuarine Water	Offshore LIS – Shellfish Sanitation	Continuing, Fixed Stations	Coliforms, MPN	Temp, Salinity	High/ Good	
	Inshore LIS – state and local Bathing Beaches	Continuing, summer season, fixed stations	Enterococci, membrane filter		High/ Good	
	Inshore LIS – Shellfish Sanitation	Continuing, Fixed Stations	Coliforms, MPN	Temp, Salinity	High/ Good	
PATHOGENS – Pressure Indicators						
Medium	Location	Status	Primary	Ancillary	Priority/ Certainty	Research
Point Sources (NPDES)	Statewide	Continuing, Permit Requirement	Coliforms		High/ Good	
Other Sources	Statewide	Continuing, Trackdown surveys for impaired shellfish areas and beaches – as needed	Coliforms, Enterococci		High/ Good	

* Immediate = as soon as funding can be found; Intermediate = 3-5 years; Long-term = 5-10 years.
** Priority reflects the importance of continuing or adding the component; Certainty reflects the prospects for continued or new funding.

Table 3.

TOXIC SUBSTANCES – State Indicators						
Medium	Location	Status*	Primary	Ancillary	Priority/ Certainty **	Research
Estuarine Water	Not Recom-mended	Long-term Considera-tion			Low/ Poor	Protocols, cost concerns
Estuarine Sediments	Sound-wide	Continuing, NCA Probabilistic Dredged Material Assessments required by permit	Priority Pollutants	TOC, Grain Size, AVS (occasion ally)	Medium/ Fair	
Estuarine Sediment Toxicity	Sound-wide	Continuing, NCA Probabilistic; Occasional Dredged Material Assessment Requirement	Toxic Effect	Priority Pollutants, TOC, Grain Size	Medium/ Fair	
Biomarkers	Sound-wide	Long-term, Investigative, not routine	Biomarkers	Toxicity	Medium/ Poor	
Biocriteria	Sound-wide	Intermediate, Research	Diversity	TOC, Grain Size, Priority Pollutants	High/ Fair	No established Biocriteria for estuarine benthos
Tissue	Sound-wide	Immediate, Infrequent Survey and NCA probabilistic	Priority Pollutants Exceeding Human Health Thresholds		High/ Fair	
TOXIC SUBSTANCES – Pressure Indicators						
Medium	**Location**	**Status**	**Primary**	**Ancillary**	**Priority/ Certainty**	**Research**
Point Sources – Chemicals in discharge and toxicity (NPDES)	Statewide	Continuing, Permit Requirement	Pollutants in Permits; Toxicity	Discharge Volume	High/ Good	
Surface Water (freshwater)	Tributary Rivers	Continuing, Fixed Stations	Metals, some organics	Flow Volume	High/ Fair	
Sediments – Legacy	Sound-wide, mostly nearshore	Continuing, TMDL or Clean up, Dredging	Priority Pollutants	TOC, Grain Size, Volume	Medium/ Fair	

* Immediate = as soon as funding can be found; Intermediate = 3-5 years; Long-term = 5-10 years.
** Priority reflects the importance of continuing or adding the component; Certainty reflects the prospects for continued or new funding.

Table 4.

LIVING RESOURCES – State Indicators						
Medium	Location	Status*	Primary	Ancillary	Priority/ Certainty**	Research
Open Water Finfish Trawl Survey	Soundwide	Continuing – Wallop-Breaux	Fish and crustacean abundance			
Nearshore Fish Survey	Harbors, coves and embayments	Continuing – Wallop-Breaux	Fish and forage abundance			
Benthos	Soundwide	Continuing, NCA Funded	Diversity		High/ Fair	
Phytoplankton	Soundwide	Continuing, Two year microscopy – NCA/LISS Funded	Diversity, Dominance, Counts		High (pigment)/ Fair	Photopigment
Eelgrass	Eastern LIS embayments	Continuing, Biannual photo-interpretation – LISS funded	Eelgrass bed area and distribution		High/ Fair	Nitrogen Criteria to protect eelgrass; Niantic River study
* Immediate = as soon as funding can be found; Intermediate = 3-5 years; Long-term = 5-10 years. ** Priority reflects the importance of continuing or adding the component; Certainty reflects the prospects for continued or new funding.						

Table 5.

NUTRIENTS	
Objective	Status of Implementation
I.1. Map the areal extent and duration of hypoxia in LIS bottom waters each summer to determine trends and efficacy of nitrogen control programs	Fully Implemented
I.2. Profile sediments every 3-5 years in hypoxic areas to ascertain severity of hypoxia and its relationship to sediment quality	Not Implemented – some surveys available – medium priority, intermediate term
I.3. Monitor nutrient distribution in LIS waters to track programmatic reductions and changes in the Sound	Fully Implemented
I.4. Monitor phytoplankton abundance and character in the Sound to determine changes related to the severity of hypoxia and the effects of nitrogen control	Fully Implemented
I.5. Monitor sources of nitrogen throughout Connecticut to develop primary source and delivery relationships that can be used to calibrate watershed models, track changes, and verify surrogate indicators such as land cover character	Fully Implemented
PATHOGENS	
Objective	Status of Implementation
II.1. Monitor and track indicator organisms at state and local bathing beaches to assure bather safety from exposure to pathogens	Fully Implemented
II.2. Monitor and track indicator organisms at commercial and recreational shellfish beds to assure shellfish products are safe for human consumption	Fully Implemented
II.3. In areas with chronic indicator effects, investigate sources through trackdown surveys and TMDL development	Fully Implemented
TOXIC SUBSTANCES	
Objective	Status of Implementation
III.1. Periodically survey and/or assemble sediment contaminant data to identify areas where toxic substances exceed environmentally acceptable concentrations	Fully Implemented
III.2. Periodically survey and/or assemble seafood contaminant data in representative species to identify potential human health risk concerns	Fully Implemented
III.3. In areas of known or suspected contamination, assess impacts on living resources using toxicity or biomarker techniques	Not Implemented – medium priority, long-term
III.4. In areas of known or suspected contamination, evaluate active contributing sources and historical sinks	Fully Implemented
III.5. Investigate through survey or monitoring emerging issues such as endocrine disruption causes and consequences or effects of polybrominated diphenyl ether (PBDE)	Not Implemented – research priority
LIVING RESOURCES	
Objective	Status of Implementation
IV.1. Monitor status of LIS open waters through annual finfish trawl surveys	Fully Implemented
IV.2. Monitor status of LIS coves, harbors and embayments through annual sampling using seines or other appropriate nearshore sampling gear	Fully Implemented
IV.3. Monitor benthos of LIS annually and interpret benthic health using biocriteria relevant to the Sound	Fully Implemented
IV.4. Monitor phytoplankton abundance and diversity in LIS open waters and harmful algal blooms in nearshore habitats	Fully Implemented
IV.5. Monitor eelgrass distribution and abundance at least biannually to track status and health of eelgrass	Fully Implemented
IV.6. Use condition of fish, benthos, phytoplankton and eelgrass to assess effects of nutrient, toxic substance and pathogen stressors on living resources and ecosystems	Partially Implemented – See Table 4

Table 6.

Medium	Location	Entity	Authority/QA
NUTRIENTS			
Estuarine Water	Offshore LIS	CT DEP	Approved QAPP – CT DEP
	Inshore LIS	CT DEP	Approved QAPP – NCA
Estuarine Sediments	Offshore LIS	Not Implemented	
PATHOGENS			
Estuarine Water	Offshore LIS – Shellfish Sanitation	CT DA/AB	ISSC/NSSA - FDA
	Inshore LIS – Bathing Beaches	CT DEP Municipalities	Approved QAPP – CT DEP Approved QAPP – All
	Inshore LIS – Shellfish Sanitation	CT DA/AB	ISSC/NSSA – FDA
TOXIC CONTAMINANTS			
Estuarine Water	Not Recommended	Not Implemented	
Estuarine Sediments	Soundwide	CT DEP/EPA	Approved QAPP – NCA
Estuarine Sediment Toxicity	Soundwide	CT DEP/EPA	Approved QAPP – NCA
Biomarkers	Soundwide	Not Implemented	
Biocriteria	Soundwide	CT DEP/EPA	Approved QAPP – NCA
Tissue	Soundwide	CT DEP/CT DOHS CT DEP/EPA	In process Approved QAPP – NCA
LIVING RESOURCES			
Open Water Finfish Trawl Survey	Soundwide	CT DEP – Marine Fisheries	Federal Aid in Sport Fish Restoration (Wallop – Breaux)
Nearshore Fish Survey	Harbors, coves and embayments	CT DEP – Marine Fisheries	Federal Aid in Sport Fish Restoration (Wallop – Breaux)
Benthos	Soundwide	CT DEP/EPA	Approved QAPP – NCA
Phytoplankton	Soundwide	CT DEP	Approved QAPP – CT DEP
Eelgrass	Eastern LIS embayments	LISS – U.S. FWS	NOAA protocols

Table 7.

Medium	Location	Entity	Data Management
NUTRIENTS			
Estuarine Water	Offshore LIS	CT DEP	In-house/STORET goal
	Inshore LIS	CT DEP	NCA/STORET
Estuarine Sediments	Offshore LIS	Not Implemented	
PATHOGENS			
Estuarine Water	Offshore LIS – Shellfish Sanitation	CT DA/AB	In-house
	Inshore LIS – Bathing Beaches	CT DEP Municipalities	In-house CT DPH
	Inshore LIS – Shellfish Sanitation	CT DA/AB	In-house
TOXIC CONTAMINANTS			
Estuarine Water	Not Recommended	Not Implemented	
Estuarine Sediments	Soundwide	CT DEP/EPA	NCA/STORET
Estuarine Sediment Toxicity	Soundwide	CT DEP/EPA	NCA/STORET
Biomarkers	Soundwide	Not Implemented	
Biocriteria	Soundwide	CT DEP/EPA	NCA/STORET
Tissue	Soundwide	CT DEP/CT DOHS CT DEP/EPA	In-house NCA/STORET
LIVING RESOURCES			
Open Water Finfish Trawl Survey	Soundwide	CT DEP – Marine Fisheries	In-house
Nearshore Fish Survey	Harbors, coves and embayments	CT DEP – Marine Fisheries	In-house
Benthos	Soundwide	CT DEP/EPA	NCA/STORET
Phytoplankton	Soundwide	CT DEP	In-house/STORET goal
Eelgrass	Eastern LIS embayments	LISS – U.S. FWS	In-house

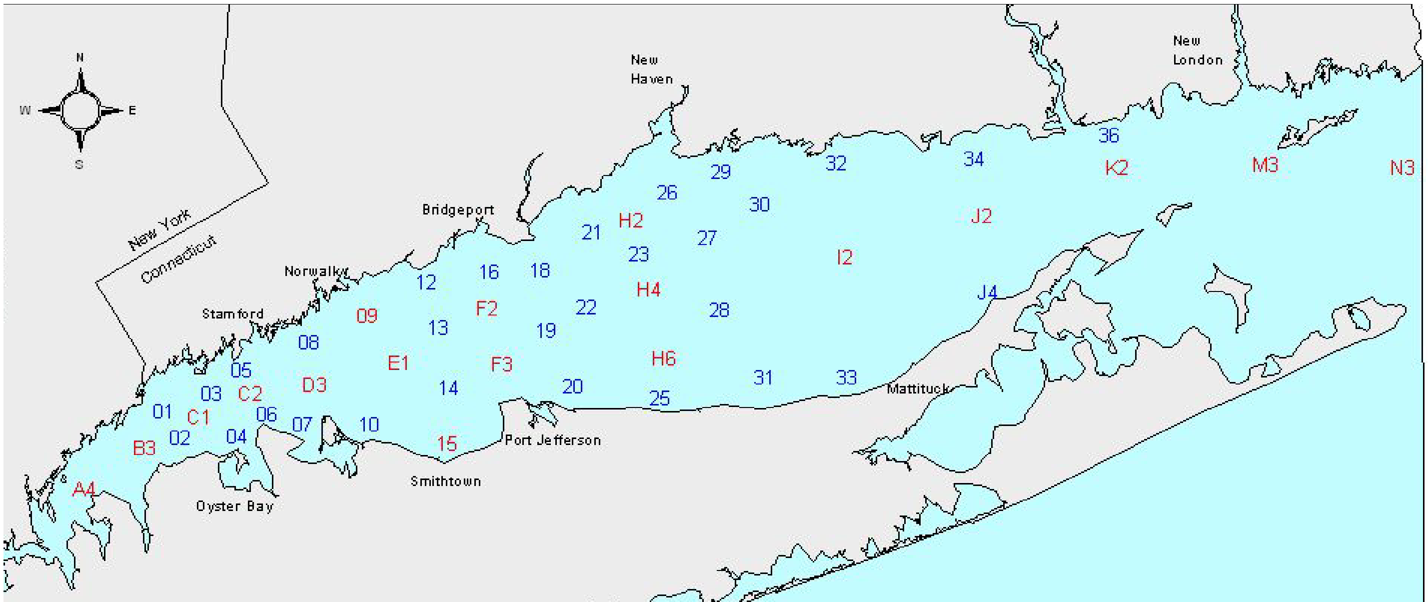

Figure 1. CT DEP nutrient (red) and hypoxia (red and blue) monitoring stations for LISS-sponsored monitoring program.

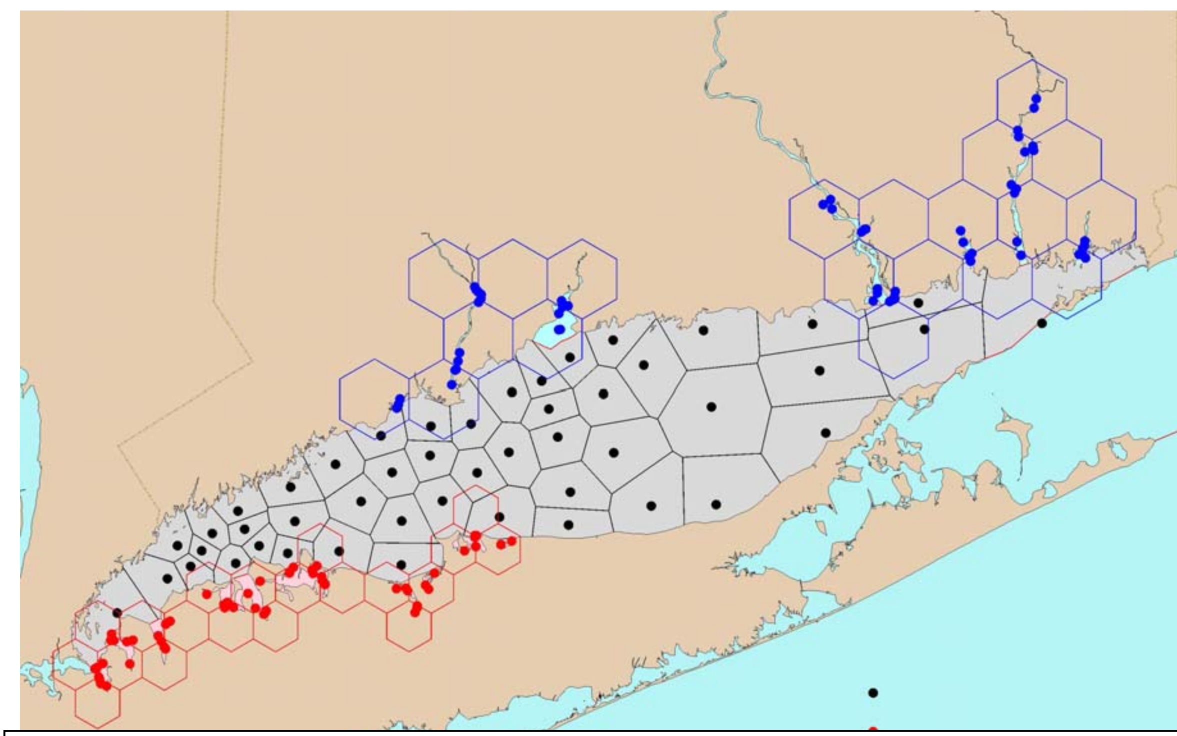

Figure 2. CT DEP offshore (black) and inshore (blue) monitoring stations for NCA-sponsored monitoring program. Red stations are in the New York NCA program.

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Appendix B

Environmental Data Management Plan

Connecticut Department of Environmental Protection, Bureau of Water Management, Planning and Standards Division

Policy Statement:

All data from environmental samples collected by Planning and Standards Division (PSD) staff or provided to PSD from external sources will be stored and maintained in an electronic data management system. Samples and the resulting data collected by PSD staff are subject to appropriate metadata documentation. This documentation will be stored in the database so as to enable long-term use of the data, facilitate migration to national water quality databases, and enable the data to be available to secondary users. PSD personnel who were responsible for the collection of the samples are required to enter all appropriate metadata into the database using a series of electronic data entry forms. Data provided to PSD from external sources may or may not contain appropriate metadata. When these external data are lacking, adequate metadata will be requested.

Introduction:

Efficient data management is essential to an effective monitoring program and has major implications for assessment, reporting, tracking, sharing data, and meeting data quality objectives. Electronic data management technology has greatly expanded our ability to manage, present, and share water quality information. It also represents a cost in terms of dedicated support staff with the specialized skills needed to obtain an optimum return on the significant investment in data management infrastructure.

The Planning and Standards Division within the Connecticut Department of Environmental Protection, Bureau of Water Management maintains an electronic data management system using Microsoft Access. This system is a relational database with referential integrity enforced. The purpose of the system is to store physical, chemical, and biological sampling results and the appropriate metadata with the intent to migrate data to EPA's national water quality database, STORET, which is accessible on the Internet. All data collected during the *Rotating Basin Strategy* beginning in 1997 resides in the Access database. Previously collected data have been stored in paper files, or in some cases using Statistical Analysis System (SAS), or spreadsheet software. Migration of this legacy data into the current system is being done in a prioritized sequence beginning with ambient biological data.

Data migration from Access to STORET is a progressive, ongoing process. As of Spring 2005 all beach monitoring data from State-owned bathing areas has been migrated to STORET.

Database Description

The major data collection projects supported by the DEP data management system include the following:

- Ambient water quality data (results of physical/chemical analysis)
- Data for resident biological communities (benthos, fish, algae)
- Fish tissue contaminant data
- Indicator bacteria data at State-owned bathing areas
- NPDES outfall data (physical/chemical and toxicity)
- Externally generated water quality and biological community data (volunteer, consultant, academic, and USGS).

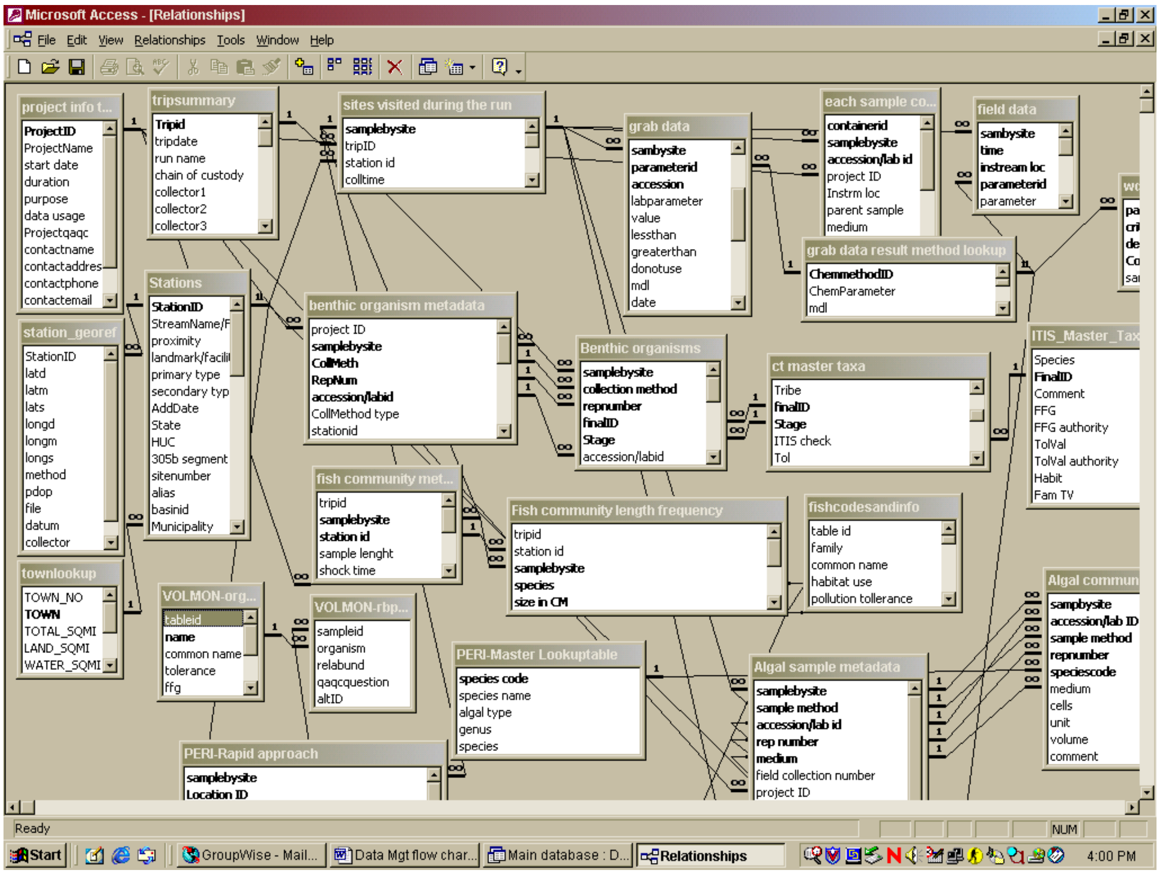
The monitoring database structure is described below. An entity relationship diagram is shown in Figure 1.

Data tables: These tables store metadata and result data. The heirarchy of these tables is as follows.

1.) Projects
2.) Trips
3.) Sites visited on the trip
4.) Samples collected at each site on the trip
5.) Results measured in the field from each site on the trip, and results determined by an analytical lab and reported to DEP.

6.) Station location metadata
Lookup tables: These tables store descriptive information about result data. These tables store information once and may be related to many result occurances. For example, pollution tolerance values, feeding groups, taxonomic hierarchy, analytical methods, citations, etc.

Figure 1
Ambient Monitoring Database Entity Relationship Diagram



Database statistics: The following statistics are approximate as of May 2005 and change frequently due to near daily addition of trips, samples and results.

Period of Record: 10/1/1995 to present. Pre-1995 data are currently being organized and structured for addition to the database.

Sampling Trips: 1508
Monitoring stations: 1578
Samples:
Physical/Chemical = 18,500
Macroinvertebrate community structure = 1,292
Fish community structure = 250
Link to DEP BNR Inland Fisheries Division = 1,200
Periphyton community structure = 181

Result records:
Physical/Chemical = 150,500

Macroinvertebrate community structure = 20,300
Fish community structure = 2,750
Link to DEP BNR Inland Fisheries Division = 8,500
Periphyton community structure = 2,633

Data management process:

The data management process requires that the sample collector(s) and the database manger work cooperatively to insure all metadata are populated in the database and are accurate. Staff that collect a sample(s) are required to populate the database with the appropriate metadata. This is accomplished using a series of electronic data entry forms. The forms are sequential beginning with logging the metadata for a TRIP, then logging the metadata for each sample container used at each site on the trip, entering pre, field, and post calibration data from field water quality instruments (if used), and finally requesting/updating station location metadata for stations where samples were collected. It is the responsibility of the database manager to maintain referential integrity and insure metadata entered by staff are consistent with the results from all samples. If discrepancies exist the data manager will work with staff to resolve the discrepancy. If metadata are not entered into the system, referential integrity will not allow results to be appended to the database.

Figure 2 is a flow chart that represents the sequence from pre-planning a sample collection trip to the analysis of environmental results. The shaded boxes with a dashed outline represent tasks completed by the database manager and the white boxes with solid outline represent tasks completed by the individual sample collector(s). The specific process for each box is described below:

Boxes 1, 1A, and A: Pre-Plan Sampling Trip: The project lead should pre-plan the sampling trip by developing a list of potential sampling locations. Once the list has been developed, the database should be queried to determine which of the locations have been established previously and which are potentially new locations. The project lead can print off location data for the existing stations. Key information would be the Database station id (unique to a sampling location), physical description of the location, and geographic coordinates (latitude and longitude). If a location does not exist in the database, the project lead must complete a data entry form to "Request a new station location". During this process the project lead will complete the metadata as accurately as possible, based on the pre-plan. Once in the field, final metadata is recorded based on actual sample collection. The database station id should be included on all field sheets and chain of custody (COC) forms.

The database manager will review each request for a new station, compare the metadata to the existing station list, and determine if the station is truly new or a slight variation in the description. All new stations are appended to the station table, a unique id is assigned automatically by the database, and this number forwarded to the project lead.

Box 2: Sample Gear Preparation: The project lead should generate a list of parameters for analysis, determine the appropriate container to use for collection, and prep all electronic field gear for use. This includes charging cellular telephone, digital camera, GPS device, and calibration of YSI meter if required.

Box 3: Sample Collection: The project lead should complete all field sheets and chain of custody forms in the field at the time of sample collection. Each sample container should be labeled with site number, date, time, and analysis (if appropriate). The chain of custody forms must cross-reference the information written on each container. For example if the site number differs from the station id, at least one of the values must be included on the sample container, the field sheet, and chain of custody form.

Box 4: Submit Samples for Analysis: The project lead should insure all samples are accounted for and should acquire a photocopy of the chain of custody form with the analytical laboratory's inventory number assigned prior to leaving the lab. If the samples are being delivered to the lab via a courier service, the sample submittal cover letter must accompany the samples. This letter instructs the analytical laboratory to fax a copy of the chain of custody with the inventory numbers ASAP.

Boxes 5, 5a and B: Log the Trip into the Database: The project lead must insure the sampling trip is logged into the database within 36 hours of completion. This is the first step in maintaining referential integrity of the results. The information logged to the database includes sampling date, collector(s) name(s), purpose, data types collected, and each site visited on the trip. At this point any sample location metadata that has changed from the pre-plan must be forwarded to the data manager. The database manager updates all appropriate fields based on the information submitted by the project lead. The most typical changes are to road names and geographic coordinates.

Box 6: Log Each Container into the Database: The project lead must insure that each container collected from each sampling location on the trip is entered into the database. The metadata for this step includes the laboratory inventory number, container type, lab name, and medium sampled, gear used, etc. The most important field is the laboratory inventory number. This is the primary link between sampling information and the reported result.

Box 7: Post calibrate sample gear: The project lead must post calibrate the YSI meter if it was used and enter the corresponding pre, field, and post calibration data into the database.

Box C: Add Results to the Database: Two types of results are appended to the database, the first are those that are submitted to a laboratory for analysis, the second are those measured directly in the field. The database manager will append both types of data to the database. For samples submitted to an analytical lab, the database manager will compare the laboratory inventory number on the electronic results to the values entered into the database by the project leader. These values must match 1 to 1. If there is a discrepancy, the database manager notifies the project lead. The photocopy of the chain of custody is used to validate data entry and/or reported results. The most common error is transcription by the project lead from hard copy to the database. For samples measured directly in the field, the database manager will compare the field sheet to the downloaded file. If there is a discrepancy, the database manager notifies the project lead. The most common error is incorrect time stamps resulting from incorrect time set in the equipment. As part of referential integrity, results will not be appended to the database without previously entered container metadata.

Box 8: Query results from the database: The project lead should review the data for the sampling trip for apparent outliers, discrepancies between duplicate samples, and exceedance of expected field blank values. Any questions regarding a result should be directed to the analytical laboratory.

Box D: Update results: The outcome of any inquiry generated by the project lead to the analytical lab will be entered into the comment field for the specific result. Note as to the change or verification of the result are included.

Box E: Export data to STORET: The data manager will export data that has passed all internal quality control checks to the national water quality database STORET. Updates to the STORET database are at a frequency compatible with project timelines

Box 9: Data Analysis: The data are available for public distribution as well as internal use. Staff are made aware to use the sample collection and analysis metadata to determine if the data will meet or not meet the objectives of their analysis. With adequate documentation the potential to use data incorrectly or exclude data unnecessarily should be minimized.

Figure 2
CT DEP Monitoring and Assessment Water Quality Data Management Flow Chart

1.) Review Proposed Sampling Locations in Database
Acquire locational metadata for each station to be sampled
Use the database station id for sample id on the chain of custody forms

A.) Review new station requests from staff
Review each new request to determine if the site
is a new location or a slightly different description of an
existing location. Append new stations to the database and forward new staion id.

1A.) If the station is new
Use "request new station form" in the database
add expected locational information
obtain GPS coordinates from "eco" the CT DEP mapping application

2.) Prep gear for sampling trip
assemble appropriate containers
Pre-calibrate YSI field meter (if using)
Charge the batteries for camera, phone, and GPS device

3.) Perform Sampling Tasks
complete chain of custody forms at time of sample collection with the
date, time, containers, database station id
use GPS device to obtain real-time coordinates

4.) Submit Samples to appropriate analytical laboratory
obtain photocopy of C.O.C with lab inventory number before relinquishing the samples

5.) Log Trip into the Database
Use the data entry form "part 1- log trip"

B.) Update station location metadata based upon
actual sample collection information

5A.) Provide field corrected information to the database;
sample location "street address, road names, etc."
provide real-time GPS coordinates

6.) Log Samples into the Database
use form "part 2- log samples"
use the copies of the C.O.C to complete a record for each container
Download YSI data & pictures to network folders

7.) Post calibrate YSI
enter pre and post calibration data to database using the calibration form

C.) Append Grab Sample Results to the Database
Upon reciept of electronic report from the lab
verify lab inventory numbers agains database
resolve metadata descrepencies

C.) Append Field Measured Results to database
Review fileld datasheets and sample metadata
verify station sample times on the field sheet vs. downloaded file

8.) Query Results from database
verify values (duplicates and blanks, outlier values)
if questions about the results contact the lab
provide outcome to data manager

D.) Document validated results
document in the database status of question (change or no chage to the reported value)

E.) Upload data to STORET
Once the data passes all internal QA/QC

9.) Data analysis

Appendix C

Connecticut
Consolidated Assessment & Listing Methodology
for 305(b) and 303(d) Reporting
(CT CALM)

April, 2004

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL
PROTECTION
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3020

Gina McCarthy, Commissioner

Table of Contents

Introduction

This assessment and listing methodology documents the decision-making process for assessing the quality of surface waters for the *Connecticut Water Quality Report to Congress*, or "305(b) Report", and for generating the list of *Connecticut Waterbodies Not Meeting Water Quality Standards* or "303(d) List". In accordance with Sections 305(b) and 303(d) of the Federal Clean Water Act (CWA), the State of Connecticut Department of Environmental Protection (CT DEP) submits a 305(b) Report and 303(d) List to the United States Environmental Protection Agency (US EPA) on even numbered years. The 305(b) Report provides information regarding the quality of all assessed waters in the State relative to their designated uses as established in the Connecticut *Water Quality Standards* (CT WQS, CT DEP 2002a). The 303(d) List documents waters impaired for one or more designated uses. For waters impaired by a pollutant or pollutants, Section 303(d) further requires that a total maximum daily load (TMDL) for identified pollutant(s) be established and allocated among dischargers.

As with many states, the Connecticut 305(b) Report and 303(d) List have historically been developed independently of each other, with some but not complete overlap of information. Despite their relationship, the statutory requirements for information gathering and public participation are slightly different for the two Sections of the CWA. Starting in 2002, following a national effort to consolidate the methodologies for both Sections, the Connecticut 303(d) List has been generated as a subset of waters assessed for the 305(b) Report. The *Consolidated Assessment and Listing Methodology* described here is the procedure by which this is done. To understand this process, it is important to put it in the context of the Federal CWA and CT WQS.

The CWA is the primary federal law that protects our nation's surface waters, including lakes, rivers, and coastal areas. In authorizing the Act, the United States Congress declared as a national goal the attainment, wherever possible, of "water quality, which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water". This goal is popularly referred to as the "fishable / swimmable" requirement of the CWA. The State of Connecticut adopted Water Quality Standards as required under Section 22a – 426 of the Connecticut General Statutes and Section 303 of the CWA to accomplish this and other water quality goals.

The CT WQS document contains policy statements concerning the protection of water quality and describes the Classification of State waters. Described for each Class are: 1) allowable discharges; 2) numeric or narrative criteria for various parameters, such as dissolved oxygen and indicator bacteria, to maintain water quality and; 3) designated uses that should be supported (Appendix A). For example, Class A surface waters have the following designated uses: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreational use; and water supply for industry and agriculture. The extent to which waterbodies support their designated uses is the key element of 305(b)/303(d) assessments. Designated use support is effectively the measure of water quality used for assessment.

Designated Uses Assessed for 305(b) and 303(d) Reporting

There are slight differences in the wording for designated uses as they are stated in the CT WQS document and as they are described in 305(b)/303(d) assessments. Designated uses are listed in Table 1 as they appear in the CT WQS (CT DEP 2002a) and as they are tracked in the US EPA Assessment Database (ADB) for nation-wide 305(b)/303(d) assessments.

Table 1. Designated uses for surface waters as described in Connecticut Water Quality Standards (CT DEP 2002) and 305(b)/303(d) Reports.

305(b) Designated Use	**CT WQS Designated Use**	**Applicable Class of Water**	**Functional Definition**
Primary Contact Recreation	Recreation	AA, A, B, SA, SB	Swimming, water skiing, surfing or other full body contact activities.
Secondary Contact Recreation	Recreation	AA, A, B, SA, SB	Boating, canoeing, kayaking, fishing, aesthetic appreciation or other activities that do not require full body contact.
Aquatic Life Support	Habitat for fish and other aquatic life and wildlife.	AA, A, B, SA, SB	Waters suitable for the protection, maintenance and propagation of a viable community of aquatic life and associated wildlife.
Fish Consumption	Not specified as a use, but implicit in "Habitat for fish and other..."[a]	AA, A, B, SA, SB	Waters supporting fish that do not contain concentrations of contaminants, which would limit consumption to protect human health.
Shellfishing	Shellfish harvesting for direct human consumption where authorized.	SA	Waters from which shellfish can be harvested and consumed directly without depuration or relay. Waters may be conditionally approved.
Shellfishing	Commercial shellfish harvesting where authorized.	SB	Waters supporting commercial shellfish harvesting for transfer to a depuration plant or relay (transplant) to approved areas for purification prior to human consumption (may be conditionally approved); also support seed oyster harvesting
Public Water Supply	Existing or proposed [b] drinking water supplies.	AA	Waters presently used for public drinking water supply or officially designated as potential public water supply.
Public Water Supply	Potential drinking water supplies.	A	Waters that have not been identified, officially, but may be considered for public drinking water supply in the future.
Navigation	Navigation	SA, SB	Waters capable of being used for shipping, travel or other transportation by private, military or commercial vessels.
Industrial	Water Supply for Industry	AA, A, B, SA, SB	Waters suitable for industrial supply.
Aesthetics	Not a designated use but included in narrative criteria.	AA, A, B, SA, SB	Appearance, odor or other characteristics of water, which impact human senses are acceptable.
Agricultural	Agriculture	AA, A, B	Waters suitable for general agricultural purposes.
Overall		AA, A, B, SA, SB	Waters supporting all of their designated uses.

[a] Also addressed in CT WQS policy statement #14: Surface waters… shall be free of chemical constituents in concentrations or combinations which will… bioconcentrate or bioaccumulate in tissues of fish, shellfish and other aquatic organisms at levels which will impair the health of aquatic organisms or wildlife or result in unacceptable tastes, odors or health risks to human consumers…

[b] Potential drinking water supplies identified in the Long Range Plan for Management of Water Resources prepared and adopted pursuant to Section 22a-352 Section 25-32d of the Connecticut General Statutes (Water Quality Standards, CT DEP 2002a).

Levels of Use Support

In making water quality assessments, each designated use of a waterbody or waterbody segment is assigned a level of support (*e.g*., full support, partial support), which characterizes the degree to which the water is suitable for that use. The following use support categories are currently used for 305(b) reporting. These are general definitions. Refer to the section in this report entitled *Assessment Methodology* (p. 9) for specific information regarding the criteria for determining levels of support for each designated use.

<u>Full Support</u> - the waterbody or waterbody segment is suitable for a designated use and will presumably continue to be suitable for that use in the future.

<u>Threatened</u> - the waterbody currently supports the designated use, but may not in the future due to degrading water quality or the existence of pollution threats that may impair water quality. This category is a subset of Full Support.

<u>Partial Support</u> - the waterbody or waterbody segment does not support the designated use at all times or under certain conditions, or the criteria used to assess support are only partially met.

<u>Not Supporting</u> - the waterbody or waterbody segment does not support the designated use.

<u>Not Attainable *</u> - the waterbody or waterbody segment has been altered to the point where there is no expectation that the use can be met (*e.g*., a section of river that is piped underground).

* The Not Attainable designation does not imply that there has been a Use Attainability Analysis. This designation has been retained for 305(b) reporting because it provides information regarding river segments that are completely enclosed in conduits or that are documented to run dry due to diversions (i.e., for all practical purposes are not attainable). For 303(d) listing however, these waters are grouped with Not Supporting so as not to be construed to have undergone a Use Attainability Analysis.

<u>Not Assessed</u> – Insufficient or no information exists to adequately assess use support.

Information Used to Assess Use Support

Depending on the waterbody and data availability, any one or combination of several types of data may be used to assess water quality and use support: ambient physical and chemical parameters, benthic invertebrate and fish community, indicator bacteria, aquatic toxicity, tissue contaminant, sediment chemistry/toxicity and effluent analysis. Following guidance from US EPA (Wayland memo, 11/19/01), the following data and information are considered in conducting water quality assessments:

- The (most recent) Section 305(b) report, including the Section 314 lakes assessment;
- The most recent Section 303(d) list;
- The most recent Section 319(a) nonpoint assessment;
- Reports of water quality problems provided by local, state, territorial or federal agencies, volunteer monitoring networks, members of the public or academic institutions;
- Reports of dilution calculations or predictive models;
- Fish and shellfish advisories, restrictions on water sports or recreational contact;
- Reports of fish kills or abnormalities (cancers, lesions, tumors);

- Water quality management plans;
- Safe Drinking Water Act Section 1453 source water assessments;
- Superfund and Resource Conservation and Recovery Act reports; and
- The most recent Toxic Release Inventory.

The primary sources of assessment information for rivers are ambient monitoring data collected by CT DEP monitoring staff, and physical, chemical and bacteria data collected at fixed sites by the United States Geological Survey (USGS). Lake assessments and trophic status are generally determined from studies conducted by CT DEP, the Connecticut Agricultural Experiment Station, USGS and Connecticut College since 1979 (Frink and Norvell 1984, Canavan and Siver 1995, Healy and Kulp 1995, CT DEP 1998) and recent studies by professional contractors. For estuaries, aquatic life use assessments are based primarily on physical and chemical monitoring by the CT DEP for the EPA National Estuary Program Long Island Sound Study. Shellfishing use support is based on bacteria monitoring and sanitary surveys conducted by the CT Department of Agriculture / Bureau of Aquaculture (CT DA-BA) for shellfish bed management.

Reasonable efforts are also made to incorporate data from other state and federal agencies, municipalities, utilities, consultants, academia, and volunteer monitoring groups. Volunteer groups and academics that receive funding through Section 319 of the CWA have data reporting requirements, which encourages the sharing of information for water quality assessments. The CT DEP also directs a monitoring program for volunteers from which usable assessment information is obtained. The details of this program, *A Tiered Approach to Citizen – Based Monitoring of Wadeable Streams and Rivers*, can be obtained from the CT DEP, Bureau of Water Management or online at http://www.dep.state.ct.us/wtr/volunmon/volopp.htm.

Other types of information that may be used for assessments include water quality surveys conducted by municipalities and discharge monitoring data from municipal sewage treatment plants, industries and remediation projects. CT DEP staff may conduct effluent or ambient toxicity tests as follow-up to suspected problems.

Knowledge of a condition known to cause water quality impairment is also considered valid information for determining use support. For example, the presence of a combined sewer overflow (CSO) in a stream segment automatically precludes primary contact use support. Use restrictions, such as beach closures, are also taken into consideration.

Data Quality and Degree of Confidence

In tracking water quality assessments, a distinction is made between waters that are considered “monitored” and waters that are considered “evaluated”. A waterbody or waterbody segment is considered monitored if the assessment is based on “sufficient and credible” ambient water quality data that are less than five years old. "Sufficient and credible" means that the quantity and quality of information can support a scientifically defensible assessment by an experienced professional familiar with waters of similar characteristics. If the data are more than five years old, not considered high quality, reflect limited sampling events, or if the assessment is made using other types of information, such as knowledge of a pollution source, the waterbody or waterbody segment is considered evaluated.

In most cases a waterbody is considered monitored when ambient data is provided by CT DEP, USGS or CT DA-BA. When volunteer or academic monitors have an EPA-approved Quality Assurance Project Plan (QAPP), their data are usually considered reliable and the waters may be considered monitored.

Where and When Water Quality is Assessed

Waterbodies and Waterbody Segments

A waterbody is a stream/river, lake/pond or estuary/embayment, which may be divided into segments. The basic assessment unit is the segment, and each segment is considered to have homogenous water quality (*i.e.*, use support is uniform throughout the segment). Typically, streams are segmented by features that may cause a change in water quality, such as a confluence with a tributary, a point source discharge, an impoundment or a significant change in land use. For the 2004 reporting cycle, 242 rivers comprising 487 segments were assessed. Almost all 147 assessed lakes were considered to each consist of one segment. (The two exceptions were a large river impoundment partially affected by low oxygen and a pair of connected ponds separated by an earthen berm.) Long Island Sound and associated embayments and estuaries were divided in to 51 waterbodies with 112 segments, largely based on shellfish bed classifications.

Stream & Rivers: Rotating Basin and Probabilistic Approaches

In 2001, the CT DEP completed statewide monitoring in wadeable streams and rivers using a five-year rotating basin strategy. The state was divided into five hydrological assessment units, each unit representing one or two major drainage basins. A different hydrologic unit was targeted for monitoring each year during the five-year cycle. This allowed CT DEP to increase the miles of assessed perennial streams from 15% to more than 25%. A more detailed explanation of this approach is found in *Ambient Monitoring Strategy for Rivers and Streams, Rotating Basin Approach* (CT DEP 1999), and assessment information obtained during the full basin rotation was reported in the 2002 305(b) Report.

Even with the increase in monitored miles resulting from the rotating basin approach, the CWA requirement to provide a description of water quality of <u>all</u> navigable waters is not possible based on this type of focused monitoring. To work toward this comprehensive assessment goal, the CT DEP with funding and cooperation from US EPA Region I conducted a pilot statewide probabilistic monitoring effort in wadeable steams during 2002-2003. Through this approach, a statistically valid sample of streams was monitored to represent conditions of all wadeable streams in the State. During this two-year period, the rotating basin approach was suspended, although some focused monitoring was still conducted at reference sites, in rivers with known problems, as follow-up to effluent treatment upgrades, and as intensive monitoring prior to and following TMDL implementation. Because all laboratory and data analyses have not been completed for probabilistic sites, a full statistical assessment of all wadeable streams will not be done until the 2006 305(b) Report. However, data from each probabilistic site and any targeted monitoring conducted during the 2002-2003 were incorporated into stream assessments on a segment-by-segment basis for the 2004 report.

For regular ambient monitoring, whether under targeted or probabilistic designs, CT DEP generally samples streams quarterly for physical and chemical parameters, and indicator bacteria. At wadeable sites, benthic macroinvertebrate collections are made during the fall index period.

Benthic community structure is used as the primary indicator of biological integrity. Fish community sampling was added at all sites during the probabilistic approach, and at a subset of sites during the rotating basin schedule. Field surveys and collections of periphyton (benthic algae) were conducted at probabilistic sites during the summers of 2002 and 2003. Analysis of algae data is not complete and will be incorporated into assessments for the 2006 reporting cycle.

In addition to monitoring conducted by CT DEP staff, a cooperative DEP/USGS fixed-network provides physical, chemical and bacteria data from approximately thirty sites located across the State. This long-term program provides data from four to twelve sampling events at each site per year on major rivers and several wadeable streams.

Lakes

Historically, Connecticut has assessed 105 - 115 "significant" lakes statewide for 305(b) reporting. Significance is based on a lake having state or federal public access, or providing unique or otherwise important habitats. In incorporating previously listed 303(d) waters into the 305(b) assessment process in 2002, a number of lakes and ponds which are not considered "significant", but are believed to have impairments, were added to the lake assessment list. Additionally, lakes and ponds with locally monitored bathing beaches have been added.

Due to staff and funding constraints, there has been no statewide ambient lake-monitoring program in Connecticut for more than a decade, and many lake assessments fall into the “evaluated” category because existing information is more than five years old. However, there has been limited targeted monitoring by CT DEP and USGS staff in lakes with known problems. Also, the Lakes Management Grant Program, administered by CT DEP, funds intensive surveys and diagnostic studies in lakes identified as having special problems or special concern to communities. These studies provide valuable information regarding contamination, eutrophication, sedimentation, and extent of aquatic plant growth. Current beach closure data are also taken into consideration for determining primary contact use support.

In 2004, CT DEP will begin a statewide probabilistic lake-monitoring program whereby 20 lakes, chosen by a stratified random design, will be monitored each year for a three-year period. Resulting data will be incorporated into lake assessments for 305(b) reporting as appropriate. Following completion of this project, CT DEP will evaluate the utility of this type of monitoring in providing assessment information and whether it is feasible to continue.

Estuaries

Long Island Sound is monitored year-round on a monthly schedule for dissolved oxygen and nutrients at 17 fixed stations; 25 - 30 stations are added during summer months. Concurrent with this effort, CT DEP collects water quality, sediment, biological community and tissue data at as many as 40 offshore and harbor sites for a US EPA probabilistic monitoring program, the National Coastal Assessment (Strobel 2000). For the national assessment, representative stations in coastal harbors and offshore waters are chosen randomly to represent conditions of the entire Sound. This information provides the basis for aquatic life use assessments. Annual shellfish bed monitoring and sanitary surveys conducted by CT DA-BA provide assessment information for shellfish use support. Beach closure information as well as known sources of pollution, such as CSOs, is used to determine primary contact use support. All estuarine waters were re-assessed using the most current information for the 2004 reporting cycle.

Reservoirs, Beaches, Fish Kills

Beach closure, drinking water reservoir trophic status and closure, and fish kill information are solicited and reported for the entire State in separate tables in the 305(b) Report. This information is incorporated into individual waterbody assessments where appropriate.

Management of Assessment information

Assessment data (*e.g.*, segment descriptions, assessment methods, use-support, causes and sources of impairment) are stored electronically by waterbody segment in an Assessment Database (ADB) provided by the US EPA. These data are submitted annually in electronic format to EPA in addition to the written biennial 305(b) Report.

Efforts are ongoing to link assessment information stored in the ADB directly to a Geographic Information System (GIS). Connecticut is part of a national initiative to index assessed surface waters to the National Hydrography Dataset (NHD). Problems related to incompatibility of map scales at the state and national levels have delayed utilization of the NHD in Connecticut. A pilot version will be available for use beginning in 2004. However, for the 2004 reporting cycle, assessment information and waterbody segmentation will be represented by simple graphics using GIS.

Raw monitoring data are managed by means of a Microsoft Access database developed by the Water Monitoring and Assessment Section of the CT DEP. This database contains sampling results and meta-data collected by the Monitoring and Assessment Section since 1997, and has greatly facilitated the assessment process. While CT DEP uses this in-house Microsoft Access database for normal monitoring and assessment purposes, EPA's STORET national water quality database is the ultimate repository for all monitoring results. Migration of CT DEP monitoring data to STORET began in 2003, with all beach data. All monitoring station information will be added in early 2004, followed by chemical, physical, and bacterial data and finally biological community information.

CT DEP TMDL staff maintains a Microsoft Access database to document progress of TMDL development and implementation. The database stores pertinent information regarding participants, waterbodies, ambient and facility monitoring data, and the status of Best Management Practices (BMPs) in achieving TMDL goals. It allows tracking participants from many programs within DEP, other government agencies and interest groups.

Assessment Methodology

Assessment procedures generally follow guidance provided by US EPA (1997) using a variety of information and data types. The CT DEP applies a "weight of evidence" approach when using multiple types of data. A waterbody is generally considered impaired when one or more sources of data or information indicate a water quality standard is not attained, providing that information is considered sufficient and fully credible (see Data Quality section, p. 6). For example, if available indicator bacteria data do not exceed criteria, but a CSO is present, the waterbody segment is considered impaired. If the benthic invertebrate community is just meeting standards, and the fish community shows impairment, the waterbody is considered impaired. In resolving discrepancies in conflicting information, consideration is given to data quality, age, frequency and site-specific environmental factors. If reconciliation of conflicting data is not possible, the waterbody segment is flagged for further monitoring.

Aquatic Life Use Support

River and Streams

Because the biological community of a stream integrates the effects of pollutants and other conditions over time, biological community assessment is the best and most direct measure of aquatic life use support (ALUS). CT DEP has used benthic macroinvertebrate community structure as the primary indicator of biological integrity since the mid-1970s. These data provide a relatively direct characterization of impairment and use support through comparison of sample communities to reference communities (Table 2). Occasionally, where habitat conditions are not optimal, a non-quantitative assessment may be used to infer aquatic life use support. Such assessments fall into the "evaluated" category. It is important to note that while CT DEP employs the methods described in US EPA's Rapid Bioassessment Protocols (RBP, Plafkin *et al*. 1989), the actual criteria for benthic invertebrates in the CT WQS (CT DEP 2002a) are narrative community descriptions, rather than numeric values.

Beginning in 1999, fish community sampling has been conducted at wadeable sites by means of a cooperative project with the DEP Fisheries Division. CT DEP intends to develop a numerical index for assessing fish community data in the future, but currently relies on the best professional judgment of fisheries and water quality monitoring staff biologists to evaluate community structure. In general, fish populations from sampled streams are compared to what would be expected in an unimpaired or minimally impaired stream of similar size. Fisheries assessments are used to support benthic information and in some cases provide the primary method to assess ALUS. Methods for both benthic invertebrate and fish monitoring are described in CT DEP (1996, 2001), Plafkin *et al*. (1989) and Barbour *et al*. (1999).

Indirect measurements of ALUS such as ambient physical/chemical data, discharge monitoring reports, aquatic toxicity monitoring reports, and sediment data are also evaluated against water quality criteria established in CT WQS (CT DEP 2002a). Decision criteria used in making ALUS assessments are provided in Table 2.

Table 2. Aquatic life use support categories and contributing decision criteria for wadeable streams.

Aquatic Life Use	**Criteria / Indicators**
Fully Supporting	• Benthic community: bioassessment indicates community is non-impaired or slightly impaired [a], and meets narrative criteria in CT WQS; RBP III Community Score (Plafkin *et al*. 1989) > 54 % of Reference Condition. • Fish community: species composition, trophic structure, and age class distribution as expected for a non-impacted stream of similar size. • Conventional physical/chemical criteria not exceeded. • Measured toxicants do not exceed chronic toxicity criteria. • No record of catastrophic events (*e.g*., chemical spills, fish kills) • No evidence of flow diversion
Threatened	• Benthic community: non-impaired or lightly impaired, but still meets narrative criteria in CT WQS; RBP III Community Score (Plafkin *et al*. 1989) > 54 % of Reference Condition, and conditions exist that may impact the community in the future. • Fish community as above, but documented trend is downward or conditions exist that may impact the community in the future. • Slight exceedences of either conventional or toxicant criteria in < 10% of samples; exceedences difficult to discern from expected analytical variability or error. • Discharge effluent constitutes >20% of stream flow. • Land use conditions exist that may cause impairment.

	• Flow reductions due to diversions have been observed.
Partially Supporting	• Benthic community: bioassessment indicates community is moderately impaired; RBP III Community Score (Plafkin *et al*. 1989) 21- 50% of Reference Condition [b]. • Fish community: species composition, trophic structure and age class distribution significantly less than expected for a non-impacted stream of similar size; diversity and abundance of intolerant species reduced; top carnivores rare; trophic structure skewed toward omnivory. • Either fish or benthic communities meet above conditions, and the other community is fully supporting. • Conventional physical/chemical criteria exceeded in > 10% but < 25% of samples. • Measured toxicants exceed chronic criteria < 10% of samples. • Flow is reduced significantly during drought conditions.
Not Supporting	• Benthic community: bioassessment indicates community is severely impaired; RBP III Community Score (Plafkin *et al.* 1989) < 17% of Reference Condition. • Fish community: species composition, age class distribution and trophic structure greatly impaired in comparison to a non or minimally impacted stream of similar size; community dominated by highly tolerant species, omnivores and habitat generalists; in extreme cases, few species present and/or diseased fish common. • Conventional physical/chemical criteria exceeded in > 25% of samples • Measured toxicants exceed chronic criteria >10% of samples • Stream known to dry completely for significant periods. • Documented catastrophic event (*e.g*., chemical spill, fish kill)
Not Attainable	Stream completely enclosed in conduit or cleared concrete trough. Stream is dewatered most of the time due to and upstream impoundment or diversion.

a. " Slightly impaired" refers to a bioassessment category (Plafkin *et al.*1989) represented by a benthic macroinvertebrate community that may show some loss of pollution-intolerant forms. In Connecticut, a slightly impaired assessment may still meet water quality standards given habitat restrictions.
b. When a bioassessment falls on the border between two use support categories, use support is determined by staff biologists with consideration site conditions and other available data.

Lakes

Levels of support for aquatic life use are based almost exclusively on the best professional judgement of CT DEP lake management staff based on the most recent available information from government agencies and/or reliable contractors and lake associations. Other factors taken into consideration are known problems, such as chronic algal blooms, extensive establishment of exotic invasive plants, severe sedimentation, and surveys of fisheries biologists.

Trophic Assessments in Lakes

Lake trophic classifications, as listed in the CT WQS (CT DEP 2002a, Appendix A) are based on ambient measurements of four parameters: total phosphorus, total nitrogen, chlorophyll a, and secchi disc transparency in specified seasons. Lakes are classified as either oligotrophic, mesotrophic, eutrophic, or highly eutrophic based on the range of values for these four parameters. Macrophyte coverage and density is used to adjust the trophic classification based on water column data described above. While trophic status is not a direct measure of aquatic community health, highly eutrophic conditions, beyond what is naturally expected (given the relative size of the lake/pond and watershed, the origin of the lake/pond, and other physiographic parameters), or a documented trend toward increased eutrophy may indicate an impairment or a threat to aquatic life. Whereas, a naturally eutrophic lake, having nutrient concentrations that support high levels of biological activity without any significant anthropogenic source, would not be considered impaired.

Estuaries

Aquatic life use assessments for estuaries are based primarily on oxygen and nutrient data collected by CT DEP's Long Island Sound monitoring staff. In cases where State water quality criteria are violated for a specific parameter as defined in the CT WQS (CT DEP 2002a), the waterbody is identified as impaired. Low dissolved oxygen, or hypoxia, in offshore waters and some embayments is the most frequently cited impairment of aquatic life. CT DEP revised its dissolved oxygen criteria in 2001 (Appendix A) for offshore bottom waters, based on risk assessment criteria published by EPA (U.S. EPA 2000). Because hypoxia is a seasonal phenomenon, affected waters are considered partially supporting rather than not supporting. Other information sources include tissue analyses, sediment analyses, irregular sampling (*e.g.*, for spills, site assessments or research projects), and professional judgment evaluations of pollutant sources and water quality conditions.

Table 3. Aquatic life use support in estuaries as determined by dissolved oxygen levels.

Aquatic Life Use Assessment	**Dissolved Oxygen Criteria**
Fully Supporting	Waters not affected by hypoxic events.
Partially Supporting	Waters affected by hypoxia for some period during the year.

Fish Consumption

Fish consumption use support is determined by consumption advisories issued by the Connecticut Department of Public Health (CT DPH). Consumption advisories are in turn based on risk assessments conducted by CT DPH using fish tissue contaminant data. A statewide fish consumption advisory was issued for all species except trout < 15 inches in the mid-1990s due to mercury contamination. This advisory was based on statewide surveys of mercury contamination in fish from lakes (Neumann 1996), and rivers (CT DEP unpublished). Therefore, in addition to fish consumption use support as determined by the criteria below (Table 4), all freshwaters of the State should technically be considered as partially supporting for fish consumption due to mercury contamination. Likewise, all estuarine waters are technically partially supporting for fish consumption due to PCB contamination in migratory striped bass and bluefish, as well as lobster tomalley.

Table 4. Fish consumption use support and criteria.

Fish Consumption Assessment	**Criteria**
Fully Supporting	No consumption advisory for any fish species or any consumer group, other than the statewide advisory for Mercury in freshwater fish or PCBs in migratory saltwater fish.
Threatened	No consumption advisory for any fish species or any consumer group, other than the statewide advisory for Mercury in freshwater fish or PCBs in migratory saltwater fish, but sediments contain detectable levels of contaminants known to bioaccumulate in fish.
Partially Supporting	A consumption advisory exists for some fish species or for certain risk consumer groups, in addition to the statewide advisory for Mercury in freshwater fish or PCBs in migratory saltwater fish.
Not Supporting	A fish consumption advisory exists for all fish species for all consumer groups.

Shellfishing (in Estuaries)

The responsibility for regulating shellfish harvest is assigned to the Department of Agriculture. The Department of Agriculture, Bureau of Aquaculture (CT DA-BA) collects fecal coliform data to assess nearshore waters to determine openings and closures of shellfish grounds

(Appendix B). Shellfish beds are classified with respect to the restrictions on harvest. There are four general classifications: 1) Approved for direct human consumption; 2) Conditionally approved for human consumption based upon rainfall, sewage treatment plant operations, season or other conditions, 3) Restricted-relay or restricted-relay/depuration operations (may also be conditional), and 4) Prohibited (may be used for oyster seed harvest). Shellfish growing water classifications are based on seawater sampling and analyses, shoreline surveys and pollution source evaluations conducted by CT DA-BA, in conformance with the Interstate Shellfish Sanitation Conference Model Ordinance. CT DEP applies these classifications to SA and SB waters to assess shellfishing use support (Table 5).

Table 5. Shellfishing use support as determined by shellfish bed classifications.

Shellfishing	**Criteria**
Fully Supporting	SA waters approved for direct harvest. SB waters approved for direct harvest, conditional harvest, or restricted to relay or depuration operations.
Partially Supporting	SA waters conditionally approved for direct harvest.
Not Supporting	SA waters prohibited to shellfishing, seed oyster harvesting or certain aquaculture operations; or approved only for relay operations. SB waters prohibited to shellfishing, seed oyster harvesting or certain aquaculture operations.

In a number of towns, the CT DA-BA has placed restrictions on direct harvest of shellfish from the shoreline out to the mid-Sound state boundary. However, beyond a depth of 50 feet, there is essentially no shellfishing conducted at this time, and these waters are not regularly monitored. Therefore, for 305(b)/303(d) purposes, shellfishing is not evaluated as a use in waters between the 50-foot depth contour and the state line. The lack of monitoring should not be construed to mean these deeper offshore waters do not achieve applicable water quality criteria for indicator bacteria.

Primary Contact Recreation

Assessment of the designated use for primary contact recreation is based, for the most part, on indicator bacteria data provided by CT DEP quarterly sampling, USGS monitoring, volunteer monitoring, and municipal monitoring (Table 6). Following the adoption of revised CT WQS in 2002, enterococci group bacteria are now used as the primary indicator organism in salt (estuarine) water, and *Escherichia coli* in fresh water. For salt water, 104 Colony Forming Units or CFU/100 ml of enterococci is the single sample criteria for designated bathing areas, 500 CFU/100 ml for other recreational uses, and 35 CFU/100 ml is the geometric mean criteria for any primary contact use. In fresh water, 235 Colony Forming Units or CFU/100 ml of *Escherichia coli* is the single sample criteria for designated bathing areas, 410 CFU/100 ml for non-designated swimming areas, 576 CFU/100 ml for other recreational uses, and 126 CFU/100 ml is the geometric mean criteria for any primary contact use. Fecal coliform data, where it exists, may be used to confirm use support determinations.

For waterbodies or waterbody segments with designated bathing areas, beach closure information rather than actual indicator bacteria data is generally used to determine use support. Public bathing areas are sampled for indicator bacteria on a weekly basis during the swimming season, which serves as the basis for determining closures (CT DPH and CT DEP 2003). Some local health departments have implemented administrative beach closures, which take effect after rainfall events of some pre-determined magnitude. In these cases, precipitation during the swimming season is also considered in evaluating beach closure information.

Additionally, beach personnel routinely conduct physical inspections of shoreline bathing areas (minimally once per day) for evidence of contamination. State and local officials also utilize sanitary surveys of shorelines and watersheds as a primary tool to determine sanitary quality. Discovery of waste materials indicative of untreated sewage or human fecal contamination (*e.g.*, medical waste, disposed condoms, tampon applicators, or diapers, sewage discharged from a boat holding tank or sewage grease balls) can be sufficient justification to support a beach closure decision by local or state authorities.

There is a distinction between occasional, small quantities of temporary and/or transient sources of human fecal contamination transported to a site (*e.g.,* diapers, tampons), and "significant" sources of contamination that originate from a fixed location within the water body (*e.g.*, a CSO or a community with failing septic systems). Any contamination determined to be of human origin would likely result in a beach closure, whereas the presence of a "significant" source would result in a water body segment being assessed as impaired.

All types of closures, whether based on bacterial exceedences or the presence of a contamination source, are included in the annual closure statistics used to assess primary contact use support. A complete discussion of Connecticut's practices related to beach closure may be found in "Guidelines for Monitoring Bathing Waters and Closure Protocol" developed jointly by the Connecticut Department of Health, the DEP, the Connecticut Environmental Health Association, the Connecticut Association of Directors of Health (CT DPH and CT DEP 2003).

In some lakes, primary contact use may also be impaired by excessive growth of aquatic invasive plants or algae. Lakes for which no bacteria data exist may be considered fully supporting of primary contact if the lake is situated completely within an undeveloped area or if there have been no complaints of illness or excessive aquatic plant growth.

Table 6. Decision criteria for various categories of primary contact use support.

Primary Contact Recreation Assessment	**Criteria / Indicators for designated public bathing areas**
Fully Supporting	• Designated bathing area closed 5% of swimming season or less; and • Sanitary survey indicates no significant source* of human fecal contamination.
Threatened	• Designated bathing area closed between 6% and 10% of swimming season; and • Sanitary survey indicates no significant source of human fecal contamination. • Land use or environmental conditions exist that may cause impairment. This may include excessive growth of aquatic weeds that threaten swimming use.
Partially Supporting	• Designated bathing area closed between 10% and 25% of swimming season; or • Sanitary survey indicates minor potential for significant source of human fecal contamination.
Not Supporting	• Designated bathing area closed more than 25% of swimming season; or • Sanitary survey indicates potential for significant source of human fecal contamination.
	Criteria / Indicators for areas not designated as public bathing areas
Fully Supporting	• Sanitary survey indicates no significant source of human fecal contamination; and • CT DEP and /or USGS ambient monitoring data show no exceedences of indicator bacteria.
Threatened	• Sanitary survey indicates no significant source of human fecal contamination; and

	• CT DEP quarterly monitoring data show a single sample exceedence of indicator bacteria; or • Limited data from another source show exceedences; or • Land use or environmental conditions exist that may cause impairment. (This may include excessive growth of aquatic weeds that threaten swimming use.); or • Stream flow comprises >20% treated sewage effluent.
Partially Supporting	• Sanitary survey indicates minor potential for significant source of human fecal contamination; or • Monthly or frequent ambient monitoring data from USGS or another reliable source show a single sample exceedence or an exceedence of the geometric mean for indicator bacteria; or • CT DEP quarterly ambient monitoring data show two extremely high or three moderate single sample exceedences of indicator bacteria. • Land use or environmental conditions exist that may cause impairment. This may include excessive growth of aquatic weeds that preclude swimming.
Not Supporting	• Sanitary survey indicates potential for significant source of human fecal contamination; or • Ambient monitoring data from USGS or another reliable source show one or more single sample exceedences and an exceedence of the geometric mean for indicator bacteria; or • Land use conditions exist known to cause impairment.
Not Attainable	• Full body contact not possible; river enclosed in conduit.

* a significant source of human fecal contamination is one that originates from a fixed location and is transported to or within the water body (*e.g.*, a CSO or a community with failing septic systems).

Secondary Contact Recreation

Secondary contact recreation (boating, fishing, *etc*.) is assessed for all lakes. Excessive growth of invasive aquatic plants may threaten or impair secondary contact uses, such as fishing or boating. The degree of impairment is based upon the best professional judgment of CT DEP lakes management staff. Also, in some rivers, where water diversions prevent normal use by canoeists and kayakers, secondary contact has been determined to be impaired. This use is assumed to be supported in all other Connecticut waters.

Drinking Water Supply

The CT DPH, in cooperation with the CT DEP, implements the federal Safe Drinking Water Act (SDWA) in Connecticut. The DPH tracks and reports on the water quality of public drinking water supplies within the context of the SDWA. Because CT DEP does not have direct access to ambient water quality information for these waterbodies, they are not tracked as waterbodies in the ADB for 305(b) assessments. However, CT DEP periodically surveys water utilities for information concerning closures, trophic status, and potential causes and sources of pollution. Trophic status is reported in a separate table in the 305(b) Report.

A number of Class AA and A tributaries to drinking water reservoirs are tracked and assessed in the ADB for 305(b) reporting. Assessment of these streams is based on standard measures of water quality (physical/chemical parameters, macroinvertebrate community, fish community, *etc.* where available), plus consideration of the potential causes and sources of pollution noted on water utility surveys.

Aesthetics

"Aesthetics" is not a designated use of waters in Connecticut WQS, rather a narrative criteria (Appendix A). Due to the ambiguous nature of measuring aesthetic use support, it is not routinely assessed for 305(b) / 303(d) reporting. For lakes, however, aesthetics is evaluated by lake managers based on best professional judgment and complaints received from the public. Complaints are usually due to excessive growth of aquatic plants or chronic algal blooms.

Navigation

Navigation is assumed to be fully supported for all SA and SB waters.

Agriculture, Industry

Agricultural and industrial supply uses are assumed to be fully supported for all AA, A, and B waters.

Overall Use Support

Overall use support is an integrated assessment that considers all designated uses in aggregate: aquatic life, primary contact, fish consumption and shellfishing (estuaries only)(Table 7). Secondary contact and aesthetics are taken into consideration for this integrated use, especially in lakes with algal or aquatic weed problems.

Table 7. Overall use support categories.

Overall Use	**Criteria**
Fully Supporting	All designated uses fully supported.
Threatened	All designated uses met, but data may show a decline in integrity. One or more uses threatened.
Partially Supporting	One designated use not supported (Estuaries); one or more uses partially supported (Rivers and Lakes)
Not Supporting	One or more designated uses not supported (Rivers and Lakes); more than one use not supported (Estuaries)
Not Attainable*	Streams that are completely dewatered due to a diversion, enclosed in a conduit or regularly cleared concrete trough.
Not Assessed	Some or none of the designated uses were assessed.

* The Not Attainable designation does not imply that there has been a Use Attainability Analysis. This designation has been retained for 305(b) reporting because it provides information regarding river segments that are completely enclosed in conduits or that are documented to run dry due to diversions (*i.e.*, for all practical purposes are not attainable). For 303(d) listing however, these waters are grouped with Not Supporting so as not to be construed to have a Use Attainability Analysis.

Listing of Unimpaired and Impaired Waters

Based on the above assessment methodology, all waters of the State may be placed in one of five categories described in the US EPA guidance (Wayland memo, 11/19/01). For 2002 and 2004 reporting, only impaired waters have been categorized pursuant to this guidance (see categories 4 and 5) for submission with the 303(d) List. All assessed waters, impaired and unimpaired waters are reported in the 305(b) report in a traditional listing by drainage basin. The five EPA categories and the subsequent monitoring recommended to support water quality management are described below:

1. Fully supporting of all uses (may be threatened for some uses [a]). Reliable data and information support a determination that the water quality standards are attained for the Class designation. These waters will be monitored in the future, in accordance with the ambient monitoring strategy adopted by the CT DEP. Waters with threatened uses may be prioritized to determine trends in water quality.

2. Fully supporting of some designated uses (may be threatened for some uses [a]); and insufficient or no data and information available to assess remaining uses. Reliable data and information exist to support a determination that some uses are attained. These waters will be monitored in the future, in accordance with the ambient monitoring strategy adopted by the CT DEP. Waters with threatened uses may be prioritized to determine trends in water quality, or better define attainment status.

3. Not assessed, insufficient or no information exists to determine if any designated use is attained. These waters may be prioritized for monitoring as considered appropriate by CT DEP staff, or may be monitored in accordance with the ambient monitoring strategy adopted by the CT DEP. Following a probabilistic approach, these waters may be assessed through statistical representation.

4. Impaired for one or more designated uses, TMDL development not required for one of the following reasons:

    a. (CT DEP Tier 1) [b] TMDL has been completed. Waters for which TMDL(s) have been developed and approved by EPA that, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the impairment of the waterbody or waterbody segment, it will remain in Category 5 until TMDLs for all pollutants have been completed and approved by EPA. Follow-up monitoring will be scheduled as specified in the approved TMDL implementation and monitoring plan, to verify that the water quality standard is met after implementation.

    b. (CT DEP Tier 4) [b] Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. These are waters where other pollution controls required by local, state, or federal authority are stringent enough to attain any water quality standard applicable to such waters. The pollution controls required are specifically applicable to the particular water quality problem. Monitoring will be scheduled for these waters to verify that the water quality standard is attained as expected.

    c. (CT DEP Tier 5) [b] Impairment is not caused by a pollutant, but by a stressor not directly related to water quality (*e.g.*, habitat modification, hydraulic modification). These waters will be monitored in the future, in accordance with the ambient monitoring strategy adopted by the CT DEP.

5. Impaired for one or more designated uses, TMDL development required. The water quality standard is not attained. This category constitutes the subset of impaired waters for which one or more TMDLs are needed (*i.e.*, the 303(d) List). Waters in this category

will be prioritized for TMDL development based on threats to human health, the potential for a TMDL analysis to result in improved water quality and the comments received during the public review of the proposed 303(d) list. A schedule will be developed for the establishment of TMDLs, describing when data and information will be collected to support TMDL establishment and to determine if standards are attained. This schedule will reflect the priority ranking of the listed waters. Waters in this category are further divided into the two following subcategories:

a. (CT DEP Tier 2) [b] It has been determined through methodology described below, that the impairment is caused by a pollutant stressor (*e.g.*, chemical, clean sediment, temperature), a surrogate indicator (*e.g.*, indicator bacteria), or can be attributed to a source that contributes multiple pollutants to a waterbody such that implementing a TMDL for one or more pollutants can reasonably be expected to result in attainment of uses. Where more than one pollutant is associated with the impairment, the waterbody or waterbody segment will remain in this category until TMDLs for all pollutants have been completed and approved by EPA. Further investigative monitoring, if necessary, will be scheduled to confirm causes. Follow-up monitoring will be scheduled to determine if standards are attained following TMDL implementation.

b. (CT DEP Tier 3) [b] The waterbody or waterbody segment does not support a use based on biological or other information, and the cause is unknown. It is uncertain whether the impairment is caused by a pollutant. Additional monitoring will be scheduled to identify the cause of impairment. If the additional monitoring determines the cause of the impairment to be a pollutant(s), and other pollution control requirements can not reasonably be expected to result in attainment of standards in the near future, the State will complete a TMDL(s) for the pollutant(s). If the additional monitoring determines the impairment is not caused by a pollutant, the waterbody or waterbody segment will be moved Category 4c.

[a] The US EPA ranking system does not considers threatened waters in category 1 or 2, but places these waters in category 4 or 5. CT DEP considers waters threatened for some uses as meeting water quality standards and does not place them in the impaired waters categories.

[b] US EPA categories 4 and 5 constitute the "Impaired Waters List" (IWL) for the State of Connecticut, documented in the *2002 List of Connecticut Waterbodies Not Meeting Water Quality Standards* (CT DEP 2002). The "Tier" designation refers to the categories used in the Connecticut IWL.

Determining Causes and Sources of Impairment

A primary focus of CT DEP monitoring and assessment staff is the evaluation of existing data and information to make use support assessments. In some cases, ambient biological community data indicate impairment, but the cause(s) and source(s) are unknown or, more often, multiple potential causes/sources exist but a direct link to impairment is lacking. Therefore, for many impaired waters listed in the 305(b)/303(d) Report, the causes and sources indicated are the best estimations of DEP monitoring staff based on a weight of evidence approach. Once a waterbody or segment is designated for TMDL development, a more thorough investigative study is conducted to identify causes and sources of impairment. These investigations may include more intensive ambient water quality sampling, aquatic toxicity studies, sediment or fish tissue analysis and/or dilution calculations of known discharges. In some cases the determination of causes and sources may not be possible.

Delisting of Impaired (303(d)) Waters

The assessment of surface waters for 305(b) reporting is an on-going process that will result in the removal of some waterbodies from the 303(d) portion of the impaired waters list (IWL), and the addition of others. A waterbody is removed from the 303(d) List when management efforts result in water quality meeting water quality standards. Additionally, a waterbody can be delisted for one of the following reasons:

1) An error was made in the initial listing causing an erroneous listing. Erroneous listings include those based on anecdotal information (information, often transmitted orally and undocumented, that can not be confirmed through direct observation or measurement using generally accepted, reproducible analytical methods).
2) Quality controlled data, which are acceptable to CT DEP, demonstrate that designated uses are being met for the waterbody (with or without implementation of a TMDL).
3) Revisions in Water Quality Standards and Criteria may cause a waterbody to come into compliance with Water Quality Standards.
4) The waterbody or waterbody segment meets conditions described in 4a - 4c in the listing methodology above.

Reconciliation of Past and Present 303(d) Lists

Apart from the ongoing process of listing and delisting 303(d) waterbodies described in the previous sections, there are cases where a waterbody may be moved to another category based on re-assessment of available information. This occurred in several cases for waters listed as impaired in 1998 based on anecdotal information. In these circumstances, the waterbody usually was moved into EPA category 2 (supporting for some uses, other uses not assessed) or more often category 3 (no or insufficient data available to make any assessment).

Public Participation

As described previously, the CT DEP solicits data and information from a variety of sources, including volunteer groups, municipalities, utilities, and academia to incorporate into the assessment process. Additionally, there is a public review process for the 303(d) List and listing methodology. Public comments are considered to the degree feasible, in providing a final 305(b)/303(d) Report to the US EPA in April 2004.

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Appendix A: Applicable Water Quality Standards and Criteria for Assessed Waters

The information provided in this appendix has been excerpted from the Connecticut Water Quality Standards (2002) to provide reference material for the Consolidated Assessment & Listing Methodology (2004). Refer to the full text of the Connecticut Water Quality Standards (http://www.dep.state.ct.us/wtr/wq/wqs.pdf) for further information and policy statements.

Allowable Discharges to Surface Waters:

(A) Class AA, A and SA surface waters: discharges may be permitted by the Commissioner from public or private drinking water treatment systems, dredging activity and dredge material dewatering operations, including the discharge of dredged or fill material and clean water discharges. In Class AA surface waters such discharges shall be subject to the approval of the Commissioner of Health Services. The Commissioner may authorize other discharges to surface waters with a Classification of SA, A or AA provided the Commissioner finds such discharge will be of short duration and is necessary to remediate surface water or ground water pollution. Any such discharge shall be treated or controlled to a level which in the judgment of the Commissioner, protects aquatic life and public health.

(B) Class B and SB surface waters: discharges may be permitted for all those allowed in Class AA, A and SA surface waters, cooling water discharges, discharges from municipal and industrial wastewater treatment systems and other discharges subject to the provisions of Section 22a-430 of the Connecticut General Statutes.

INLAND SURFACE WATERS CLASSES AND CRITERIA

CLASS AA

Designated Uses- These surface waters are designated for: existing or proposed drinking water supplies; habitat for fish and other aquatic life and wildlife; recreation; and water supply for industry and agriculture.

Parameter		Criteria
1.	Aesthetics	Uniformly excellent.
2.	Dissolved oxygen	Not less than 5 mg/l at any time.
3.	Sludge deposits-solid refuse- floating solids-oils and grease-scum	None other than of natural origin.
4.	Color	None other than of natural origin.

5.	Suspended and settleable solids	None in concentrations or combinations which would impair designated uses; none aesthetically objectionable; none which would significantly alter the physical or chemical composition of the bottom; none which would adversely impact aquatic organisms living in or on the bottom substrate.
6.	Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity or dredging activity or discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.
7.	Turbidity	Shall not exceed 5 NTU over ambient levels and none exceeding levels necessary to protect and maintain all designated uses. All reasonable controls or Best Management Practices are to be used to control turbidity.
8.	Indicator bacteria	See Appendix B.
9.	Taste and odor	None other than of natural origin.
10.	pH	As naturally occurs.
11.	Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 85 degrees F, or in any case raise the temperature of surface water more than 4 degrees F.
12.	Chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Water Quality Standards (2002) numbers 10, 12, 13, and 19.
	(a) Phosphorus	None other than of natural origin
	(b) Sodium	Not to exceed 20 mg/l
13.	Benthic invertebrates which inhabit lotic waters	A wide variety of macroinvertebrate taxa should normally be present and all functional feeding groups should normally be well represented. Presence and

productivity of aquatic species is not limited except by natural conditions, permitted flow regulation or irreversible cultural impacts. Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. Taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Coleoptera (beetles) and Trichoptera (caddisflies) should be well represented.

CLASS A

Designated Uses - These surface waters are designated for: habitat for fish and other aquatic life and wildlife; potential drinking water supplies; recreation; and water supply for industry and agriculture.

Parameter	Criteria
1. Aesthetics	Uniformly excellent.
2. Dissolved oxygen	Not less than 5 mg/l at any time.
3. Sludge deposits solid refuse – floating solids –oils and grease-scum.	None other than of natural origin.
4. Color	None other than of natural origin
5. Suspended and settleable solids	None in concentrations or combinations which would impair designated uses; none aesthetically objectionable; none which would significantly alter the physical or chemical composition of the bottom; none which would adversely impact aquatic organisms living in or on the bottom substrate.
6. Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, dredging activity or the discharge of dredged or fill materials provided all reasonable controls or best management practices are used in such activities and all designated uses are protected and maintained.
7. Turbidity	Shall not exceed 5 NTU over ambient levels and none exceeding levels necessary to protect and maintain all designated uses. All

		reasonable controls or Best Management Practices are to be used to control turbidity.
8.	Indicator Bacteria	See Appendix B.
9.	Taste and odor	None other than of natural origin.
10.	pH	As naturally occurs.
11.	Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 85 degrees F, or in any case raise the temperature of surface water more than 4 degrees F.
12.	Chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Water Quality Standards (2002) numbers 10, 12, 13, and 19.
	(a) Phosphorus	None other than of natural origin.
	(b) Sodium	None other than of natural origin.
13.	Benthic invertebrates which inhabit lotic waters.	A wide variety of macroinvertebrate taxa should normally be present and all functional feeding groups should normally be well represented. Presence and productivity of aquatic species is not limited except by natural conditions, permitted flow regulation or irreversible cultural impacts. Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. Taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies), Coleoptera (beetles) and Trichoptera (caddisflies) should be well represented.

CLASS B

Designated Uses - These surface waters are designated for: habitat for fish and other aquatic life and wildlife; recreation; and industrial and agricultural water supply.

Parameter		**Criteria**
1.	Aesthetics	Good to excellent
2.	Dissolved oxygen	Not less than 5 mg/l at any time.
3.	Sludge deposits - solid refuse -	None except for small amounts that may result from the discharge from a permitted waste treatment facility and none

	floating solids - oil and grease – scum	exceeding levels necessary to protect and maintain all designated uses.
4.	Color	None which causes visible discoloration of the surface water outside of any designated zone of influence.
5.	Suspended and settleable solids	None in concentrations or combinations which would impair the most sensitive designated use; none aesthetically objectionable; none which would significantly alter the physical or chemical composition of the bottom; and none which would adversely impact aquatic organisms living in or on the bottom sediments; shall not exceed 10 mg/l over ambient concentrations.
6.	Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, dredging activity or discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.
7.	Turbidity	Shall not exceed 5 NTU over ambient levels and none exceeding levels necessary to protect and maintain all designated uses. All reasonable controls or Best Management Practices are to be used to control turbidity.
8.	Indicator bacteria	See Appendix B.
9.	Taste and odor	None that would impair any uses specifically assigned to this Class.
10.	pH	6.5 - 8.0
11.	Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 85 degrees F, or in any case raise the temperature of the receiving water more than 4 degrees F.
12.	Chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Water Quality Standards (2002) numbers 10, 11, 12, 13, 17, and 19.
13.	Benthic invertebrates which inhabit lotic waters	Water quality shall be sufficient to sustain a diverse macroinvertebrate community of indigenous species. All functional feeding groups and a wide variety of macroinvertebrate taxa shall be present, however one or more

may be disproportionate in abundance. Waters which currently support a high quality aquatic community shall be maintained at that high quality. Presence and productivity of taxa within the Orders Plecoptera (stoneflies), Ephemeroptera (mayflies); and pollution intolerant Coleoptera (beetles) and Trichoptera (caddis- flies) may be limited due to cultural activities. Macroinvertebrate communities in waters impaired by cultural activities shall be restored to the extent practical through implementation of the department's procedures for control of pollutant discharges to surface waters and through Best Management Practices for non-point sources of pollution.

LAKE TROPHIC CATEGORIES

Criteria for Total Phosphorus, Total Nitrogen, Chlorophyll-a, and Secchi Disk Transparency appearing in the table below represent acceptable ranges for these parameters within which recreational uses will be fully supported and maintained for lakes in each trophic category. For the purpose of determining consistency with the water quality standards for lakes classified AA, A or B, an assessment of the natural trophic category of the lake, absent significant cultural impacts, must be performed to determine which criteria apply.

OLIGOTROPHIC

May be Class AA, Class A, or Class B water. Low in plant nutrients. Low biological productivity characterized by the absence of macrophyte beds. High potential for water contact recreation.

	Parameters	Criteria
1.	Total Phosphorus	0-10 ug/l spring and summer
2.	Total Nitrogen	0-200 ug/l spring and summer
3.	Chlorophyll-a	0-2 ug/l mid-summer
4.	Secchi Disk Transparency	6 + meters mid-summer

MESOTROPHIC

May be Class AA, Class A, or Class B water. Moderately enriched with plant nutrients. Moderate biological productivity characterized by intermittent blooms of algae and/or small areas of macrophyte beds. Good potential for water contact recreation.

	Parameters	Criteria
1.	Total Phosphorus	10-30 ug/l spring and summer
2.	Total Nitrogen	200-600 ug/l spring and summer
3.	Chlorophyll-a	2-15 ug/l mid-summer
4.	Secchi Disk Transparency	2-6 meters mid-summer

EUTROPHIC

May be Class AA, Class A, or Class B water. Highly enriched with plant nutrients. High biological productivity characterized by frequent blooms of algae and/or extensive areas of dense macrophyte beds. Water contact recreation opportunities may be limited.

	Parameters	Criteria
1.	Total Phosphorus	30-50 ug/l spring and summer
2.	Total Nitrogen	600-1000 ug/l spring and summer
3.	Chlorophyll-a	15-30- ug/l mid-summer
4.	Secchi Disk Transparency	1-2 meters mid-summer

HIGHLY EUTROPHIC

May be Class AA, Class A, or Class B water. Excessive enrichment with plant nutrients. High biological productivity, characterized by severe blooms of algae and/or extensive areas of dense macrophyte beds. Water contact recreation may be extremely limited.

	Parameters	Criteria
1.	Total Phosphorus	50 + ug/l spring and summer
2.	Total Nitrogen	1000 + ug/l spring and summer
3.	Chlorophyll-a	0-1 meters mid-summer

COASTAL WATERS, CLASSES & CRITERIA.

CLASS SA -

Designated Uses - These surface waters are designated for: habitat for marine fish, other aquatic life and wildlife; shellfish harvesting for direct human consumption where authorized; recreation; industrial water supply; and navigation.

Parameter		Criteria
1.	Aesthetics	Uniformly excellent.
2.	Dissolved Oxygen	Not less than 6.0 mg/l at any time in the nearshore waters of Long Island Sound, including harbors, embayments and estuarine tributaries.

		Not less than 6.0 mg/l at any time in the offshore waters of Long Island Sound, above the seasonal pycnocline and throughout the Sound when no pycnocline is established. Not less than 3.5 mg/l for offshore waters within and below the seasonal pycnocline. Cumulative periods of dissolved oxygen in the 3.5 - 4.8 mg/l range shall not exceed exposure parameters detailed in the *Dissolved Oxygen (DO) Criteria for Offshore Coastal Waters* at the end of this appendix.
3.	Sludge Deposits-solid-refuse, floating-solids, oils and grease scum	None other than of natural origin.
4.	Color	None other than of natural origin.
5.	Suspended and settleable solids	None, other than of natural origin.
6.	Silt or sand deposits	None other than of natural origin except as may result from normal agricultural. Road maintenance, construction activity, dredging activity or discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.
7.	Turbidity	None other than of natural origin except as may result from normal agricultural, road maintenance, or construction activity, dredging activity or discharge of dredged or fill materials provided all reasonable controls and Best Management Practices are used to control turbidity and none exceeding levels necessary to protect and maintain all designated uses.
8.	Indicator bacteria	See Appendix B.
9.	Taste and odor	As naturally occurs.
10.	pH	6.8 - 8.5
11.	Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and in no case exceed 83 degrees F, or in any case raise the temperature of the receiving water more than 4 degrees F. During the period including July, August, and September, the temperature of the receiving water shall not be raised more than 1.5 degrees F unless it can be shown that spawning and growth of

indigenous organisms will not be significantly affected.

12.	Chemical constituents	None in concentrations or combinations which would be harmful to designated uses. Refer to Water Quality Standards (2002) numbers 10, 12, 13, and 19.

CLASS SB

Designated Uses - These waters are designated for: habitat for marine fish, other aquatic life and wildlife; commercial shellfish harvesting where authorized; recreation; industrial water supply; and navigation.

Parameter		Criteria
1.	Aesthetics	Good to excellent.
2.	Dissolved Oxygen	Not less than 5.0 mg/l at any time in the near shore water of Long Island Sound, including harbors, embayments and estuarine tributaries. Not less than 5.0 mg/l at any time in the offshore waters of Long Island Sound above the seasonal pycnocline and throughout the Sound when no pycnocline is established. Not less than 3.5 mg/l for offshore waters within and below the seasonal pycnocline. Cumulative periods of dissolved oxygen exposure in the 3.5 – 4.8 mg/l range shall not exceed parameters detailed in Appendix C.
3.	Sludge deposits solid refuse – floating solids – oils and grease-scum	None except for small amounts that may result from the discharge from a grease waste treatment facility providing appropriate treatment and none exceeding levels necessary to protect and maintain all designated uses.
4.	Color	None resulting in obvious discoloration of the surface water outside of any designated zone of influence.
5.	Suspended and settleable solids	None in concentrations or combinations which would impair the designated uses; none aesthetically objectionable; none which would significantly alter the physical or chemical composition of bottom sediments; none which would adversely impact organisms living in or on the bottom sediment.

6.	Silt or sand deposits	None other than of natural origin except as may result from normal agricultural, road maintenance, construction activity, dredging activity or discharge of dredged or fill materials provided all reasonable controls or Best Management Practices are used in such activities and all designated uses are protected and maintained.
7.	Turbidity	None other than of natural origin except as may result from normal agricultural, road maintenance, or construction activity, or discharge from a waste treatment facility providing appropriate treatment, dredging activity or discharge of dredged or fill materials provided all reasonable controls and Best Management Practices are used to control turbidity and none exceeding levels necessary to protect and maintain all designated uses.
8.	Indicator bacteria	See Appendix B.
9.	Taste and odor	As naturally occurs. None that would impair any uses specifically assigned to this Class.
10.	pH	6.8 - 8.5
11.	Allowable temperature increase	There shall be no changes from natural conditions that would impair any existing or designated uses assigned to this Class and, in no case exceed 83 degrees F, or in any case raise the temperature of the receiving water more than 4 degrees F. During the period including July, August, and September, the temperature of the receiving water shall not be raised more than 1.5 degrees F unless it can be shown that spawning and growth of indigenous organisms will not be significantly affected.
12.	Chemical constituents	None in concentrations or combinations which would be harmful to the designated uses. Refer to Water Quality Standards (2002) numbers 10, 12, 13, and 19.

Appendix B: Water Quality Criteria for Bacterial Indicators of Sanitary Quality

SEE ALSO STANDARDS # 23 AND 25

DESIGNATED USE	CLASS	INDICATOR	CRITERIA
<u>Freshwater</u>			
Drinking Water Supply (1)			
Existing / Proposed	AA	Total Coliform	Monthly Moving Average less than 100/100 ml Single Sample Maximum 500/100ml
Potential	A	----	--------
Recreation (2)(3)			
Designated Swimming (4)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 235/100ml
Non-designated Swimming (5)	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 406/100ml
All Other Recreational Uses	AA, A, B	*Escherichia coli*	Geometric Mean less than 126/100ml Single Sample Maximum 576/100ml
<u>Saltwater</u>			
Shellfishing			
Direct Consumption	SA	Fecal Coliform	Geometric Mean less than 14/100ml 90% of Samples less than 43/100ml
Commercial Harvesting	SB	Fecal Coliform	Geometric Mean less than 88/100ml 90% of Samples less than 260/100ml
Recreation			
Designated Swimming (4)	SA, SB	Enterococci	Geometric Mean less than 35/100ml Single Sample Maximum 104/100ml
All Other Recreational Uses	SA, SB	Enterococci	Geometric Mean less than 35/100ml Single Sample Maximum 500/100ml

Table Notes:

(1) Criteria applies only at the drinking water supply intake structure.

(2) Criteria for the protection of recreational uses in Class B waters do not apply when disinfection of sewage treatment plant effluents is not required consistent with Standard 23.

(3) See Standard # 25.

(4) Procedures for monitoring and closure of bathing areas by State and Local Health Authorities are specified in: <u>Guidelines for Monitoring Bathing Waters and Closure Protocol</u>, adopted jointly by the Department of Environmental Protection and the Department of Public Health, May 1989, revised June 1992.

(5) Includes areas otherwise suitable for swimming but which have not been designated by State or Local authorities as bathing areas, waters which support tubing, water skiing, or other recreational activities where full body contact is likely.

Guidelines for Use of Indicator Bacteria Criteria

Water Quality Classifications are reviewed approximately every three years at which time all available water quality monitoring data is considered along with other relevant information. Relevant information includes but is not limited to federal guidance concerning the scientific basis for deriving the criteria and the potential health risks associated with excursions above the criteria, recommended implementation procedures, and the results of sanitary surveys or other investigations into sources of indicator bacteria in the watershed. Public input is also solicited and considered in determining the existing water quality conditions and water quality goals. Nevertheless, the Water Quality Classification may not be an accurate representation of current water quality conditions at any particular site. For this reason, <u>the Water Quality Classification should not be considered as a certification of quality by the State or an approval to engage in certain activities such as swimming or shellfish harvest</u>

Appendix C: Dissolved Oxygen (DO) Criteria for Offshore Coastal Waters

***Background**:* Offshore Coastal DO criteria are based on the Environmental Protection Agency's *Ambient Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras*, noticed November 30, 2000 in the Federal Register (65(231):71317-71321).

***Area Affected**:* DO criteria different from the 6.0 mg/l and 5.0 mg/l minimums for Class SA and SB offshore waters apply only in and below the pycnocline of Long Island Sound (LIS) where stratification occurs during warm, summer conditions. Offshore waters are defined as areas of LIS greater than 5m in depth at mean low water. Offshore waters above the pycnocline generally have ample DO from photosynthesis and wave-driven diffusion.

Cumulative DO exposure parameters: DO conditions in the area affected do not readily lend themselves to a single numeric criterion as is often done with toxic contaminants. Aquatic organisms are harmed based on a combination of minimum oxygen concentration and duration of the low DO excursion. A DO concentration of 4.8 mg/l would meet the chronic criteria for growth and protect estuarine organisms resident in LIS regardless of duration. If oxygen fell within a 0.5 mg/l incremental range below 4.8 mg/l (*i.e.,* between 4.3 and 4.8 mg/l), a duration of 21 days or less would meet resource protection goals. Based upon the EPA research and data, similar exposure allowances were used by the Connecticut DEP for each 0.5 mg/l increment (see Table 1). The minimum DO level that can be associated with the draft EPA DO criteria document (i.e. the level below which there would be no exposure period consistent with resource protection) is 2.3 mg/l. Given the environmental variability, DEP has used more protective minimum DO criteria of 3.5-3.8 mg/l with no more than 5 days exposure.

Because estuarine systems are variable, DO levels are unlikely to remain within one of the three incremental ranges presented in Table 1. Typically, DO conditions would fall through a range to a minimum and then begin to rebound depending on weather and stratification conditions. To account for this, the number of days within each incremental DO range is pro-rated, as follows. A decimal fraction is calculated for each range, *e.g.*, 10.5 days in the 4.3-4.8 mg/l range would produce a decimal fraction of 0.50 (10.5 days/21 days). As long as the sum of those fractions calculated for each range is less than 1.0, resource protection goals are maintained for larval recruitment.

Table 1. DO incremental ranges and duration (exposure) data to be applied to LIS in the area affected to ensure protection of larval recruitment.

DO Range (mg/l)		No. of Days Allowed
Maximum	Minimum	
4.8	4.3	21
4.3	3.8	11
3.8	3.5	5